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A Large Bathhouse, White Sulphur Springs, W. Va.

The two views on this page show the exterior and the main pool of a large and ornamental bathhouse which has been recently completed at White Sulphur Springs, W. Va., for the White Sulphur Springs Hotel, a property of the Chesapeake & Ohio Ry. The building proper has a frontage of 170 ft. and a depth of 106 ft., and contains a basement and three stories. As shown in Fig. 3, there is a main center section, most of which is given over to the very large swimming pool and two side wings which are to be devoted to steam and medicinal baths.

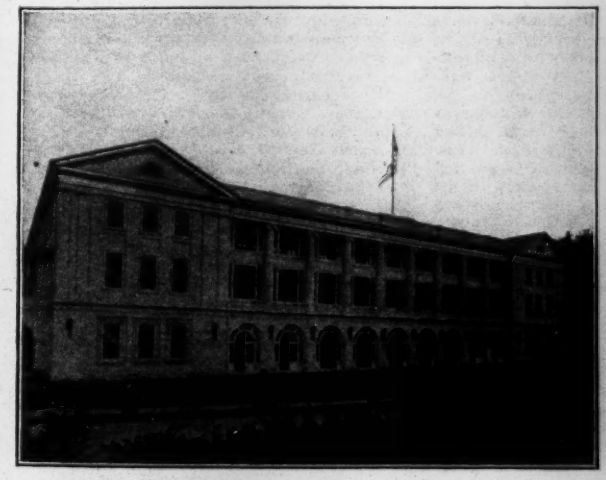

FIG. 1. BATH HOUSE, WHITE SULPHUR SPRINGS

FIG. 2. VIEW OF POOL

The main structure is of brick with steel girders and beams, but a portion, as shown on the cross-section through the center in Fig. 3, is built of cast-iron columns with ordinary timber floor construction, while the first floor and the swimming tank proper are built of reinforced concrete. Aside from the swimming pool, the structure has no point of novelty except for the high degree of ornamentation which has been used in the exterior and in portions of the interior. It is reported to be the largest structure devoted to the purpose in this country, and certainly it is one of the most pleasing architecturally.

The swimming pool is 39 ft. wide and 102 ft. long, excavated as shown in Fig. 3 from below the earth surface on one side for its full depth and for a portion of its depth on the other. It has a maximum depth of 9 ft., shallowing up to 3 ft. at the other end of the pool. On both sides are loggias leading into the dressing rooms for the bathers, and the roof, a timber truss construction with skylights, is supported by a row of cast-iron columns placed around the front of the loggia area. The pool holds 188,000 gal. of water which can be supplied from three sources, a near-by creek, a reservoir or a series of wells provided for the purpose. Filters, heaters and a circulating pump, which keeps the water in the pool clear and clean and at a constant temperature of about 73° F., are located in the basement immediately adjacent to the pool.

The sides of the pool are reinforced-concrete walls 18 in. thick and buttressed every 11 ft. 6 in. with 24-in. buttresses placed as shown in Fig. 4. These walls are continuous with the bottom floor slabs of the tank and are joined thereto by the interlocking of the reinforcement. This reinforcement, as well as the reinforcement of the walls proper, is shown on Fig. 4.

It was at first intended to use a waterproofing compound of the membrane type to keep the tank watertight, but before construction was commenced this was changed to the design shown in Fig. 4. In this design the wall and floor were built as one structure with a cross mesh of reinforcing rods near both surfaces as shown and the vertical portion of the wall was then laid up with hard brick laid in cement mortar, while the floor and the curve portions at the joints were laid up in concrete to the same distance from the previously laid concrete. This brickwork was then coated with a cement mortar and tile were laid in the mortar and hammered tight into it until the joint flushed to the surface. The whole interior surface of the pool, including the scum gutter, was laid up as rapidly as possible with the tile in this manner. So far the method has proved entirely satisfactory and no leaks have shown through the wall either in its main portion or in the places where pipe penetrates the brick and tile.

The entire structure cost when completed, about $250,000. It was designed by Messrs. Harris & Richard, architects, of Philadelphia, Penn., and the main contract was held by R. H. Richardson & Son, of Norfolk, Va. We are indebted to Charles E. Dexter, the superintendent of construction on the work, for the above information and the accompanying illustrations.

Track Maintenance Accounts on Electric Railways*

We submit in the accompanying table a comparison of the cost per car mile of track for track maintenance on four different interurban roads. The writer of the report says:

I do not think that a car-mileage basis is a proper method on which to determine whether a section of track is costing too much or too little to maintain. The principal requisites for maintaining a good smooth and safe track are: 1, good drainage; 2, good ballast; 3, good ties, well tamped and surfaced, and 4, good rails and fastenings.

It costs just as much to drain properly and keep drained a section of track over which 10,000 car-miles are run as it does to run 100,000 car-miles over the same section. The same is to quite an extent true of ballast. The ties rot out just as quickly in one case as in the other. Track bolts rust and when being tightened break and have to be replaced about as fast on the road that runs a few car-miles as on the one that runs many. It is necessary to keep the track in just as safe condition and it is just about as essential to the service that the track be kept smooth when hourly service is run with one fast and heavy car, as it is when running trains of two or more cars. Our cars are as heavy as on the other roads in the table.

While it is true that a little more labor is required to keep a track surfaced where a great number of cars are run than where only a few are operated, it must be admitted that the greatest difference in cost is on wear and tear of rails and special work.

For the above reasons it seems to me that the cost per mile of track per year is a fairer and more proper method of arriving at the cost of track maintenance for comparative purposes. On this basis our track maintenance is lower than on the three interurban roads listed.

COST OF TRACK MAINTENANCE PER CAR-MILE AND PER MILE OF TRACK

Road	Car-Miles	Cost per Car-Mile	Miles of Track	Cost per Mile of Track per Year
		c.		$
1.....	464,300	2.90	26.6	506
2.....	1,899,500	1.97	65.2	573
3.....	5,131,000	1.16	97.5	610
4.....	820,400	2.11	31.1	556

*Extract from a statement accompanying the report of a joint committee on "A Statistical Unit for Car Operation," presented at the annual meeting of the American Electric Railway Accountants Association and American Electric Railway Transportation and Traffic Association, at Chicago, Oct. 7-11.

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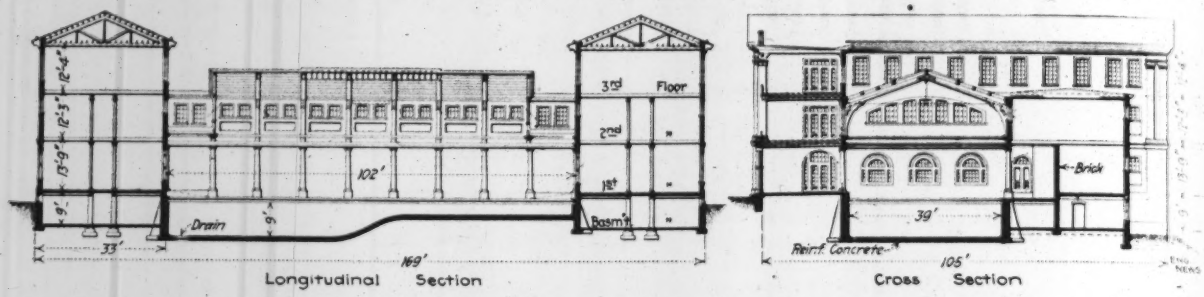

FIG. 3. LONGITUDINAL AND CROSS-SECTIONS OF BATH HOUSE, WHITE SULPHUR SPRINGS

A School of Building was established in 1904 by the London County Council, the general administrative body for Greater London. "The Surveying and Housing World," of London, comments on this school and allied subjects as follows:

So far as comprehensiveness of scope and thoroughness in its own industry are concerned the only other institution fit to rank with it is said to be the Royal Technical High School at Charlottenburg, Berlin, in its building sections, which, by the way, form the larger part, for which reason London's school has been called "The English Charlottenburg." The Structural Engineering Section is an interesting departure, as its establishment now renders the school completely on a par with Charlottenburg, where "[illegible] Ingenieurwerk" has for long been a [illegible] and important section.

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amination therein. New building laws for reinforced concrete and steelwork have recently been imposed in London, and these are subjects to which the school was the first to devote adequate attention. The school is the best equipped in this direction with testing appliances, machinery, tools, and apparatus for practical work. Several new testing machines have been installed this summer ready for next session. The course in structural engineering is a very complete one, including, in addition to steelwork, reinforced concrete and masonry structures, instruction in heavy timber work, fire-resisting construction and fire prevention, and architectural acoustics. The specialist lecturer for these subjects is H. Kempton Dyson, Secretary of the Concrete Institute, who is assisted by R. Graham Keevill, and Mr. A. E. Crabbe. Further particulars are obtainable from the Secretary of the L.C.C. School of Building, Ferndale Road, Brixton, S. W.

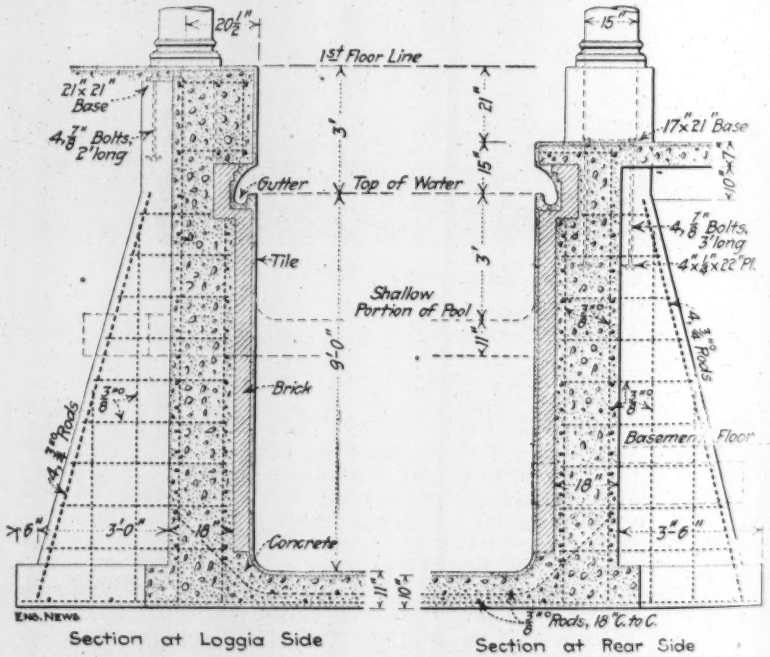


FIG. 4. DETAILS OF WALLS AND FLOOR OF BATH HOUSE, WHITE SULPHUR SPRINGS, W. VA.

Fire Shutters for Skyscrapers

By David H. Ray*

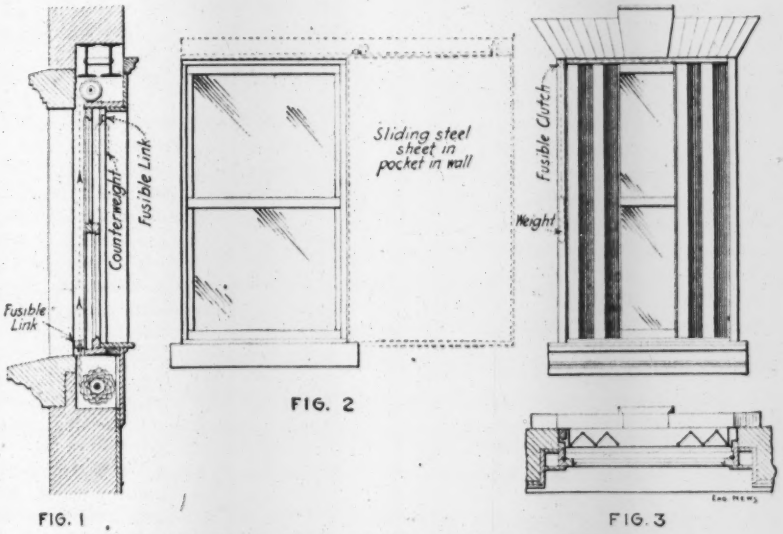
The gravest problem in connection with the ever increasing growth of the skyscraper building is the danger to life and property from fire above the 150-ft. level. The average roofline in lower New York is now about 200 ft. above the curb. No building which does not rise above this line can be seen from the harbor, nor claim the title of skyscraper in these days of 500-ft. buildings.

At or about the 100-ft. level it is possible to fight a fire from within and from without, the surrounding structures affording points of vantage for the firemen. From these structures they can not only fight back the fire, or hold it within the masonry walls, but they can also, as a rule, deluge the nearest adjoining buildings with a "water screen" to keep the flames from breaking through the glass windows and extending the conflagration.

Above the 150- or 200-ft. level, however, the problem of fighting a fire is most difficult. It is conceivable that a fire in a room at the 200-ft. level, breaking through the glass windows, under favorable conditions, might spread to adjoining rooms and rooms above until a floor or two of the building was in flames, in such event, it is probable that the fire would spread through and burn out all of the floors above.

Assuming, for example, that in the new Woolworth Bldg., 55 stories and 750 ft. high, a fire occurs on the 500-ft. level and gains headway, by cracking the plate-glass windows above and spreading upward, it is very likely that the contents of the upper 250 ft. of the building would burn like a torch, beyond control of the fire department's best endeavors. This does not necessarily mean any great loss of life. Indeed it might readily happen that not a life might be lost. Nor does it mean the destruction of the building, for the framework would doubtless remain intact after the fire. But such a torch of flame flaring over the city would throw a shower of sparks that might soon start a dozen fires in many directions on the roofs of the low buildings below, and present the danger of a large conflagration.

The remedy for this situation is to require incombustible screens or shutters on all windows above a height of 200 ft. Wire glass is but a makeshift and is seriously objected to by the architects on esthetic grounds, and also by tenants. But a drop shutter of steel released by the melting of a clutch of wire solder is entirely practicable and would fight a fire at its inception in the most efficient way, by cutting off the supply of fuel.



FIGS. 1-3. THREE TYPES OF FUSIBLE LINK FIRE SHUTTERS

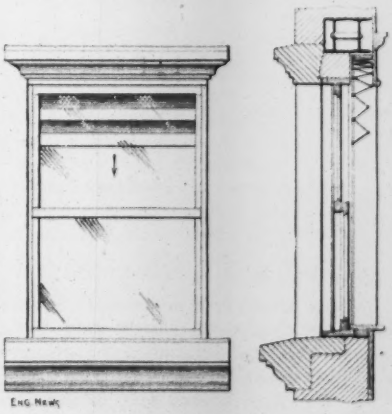


FIG. 4. TYPE OF SHUTTER ADVOCATED BY MR. RAY

The possibility of requiring a sprinkler system throughout a tall structure such as the new Municipal Building for New York City is also evident, but not called for. Assuming a fire in a waste-paper basket or in a stove, there are two evident ways of nullifying it. The first is to deluge the fire and also everything round about with water, the other alternative is to shut off the supply of fuel and cut down the draft, or smother the fire.

It is therefore highly desirable that the windows above the 200-ft. level be arranged with automatic shutters that will close in a fire and confine it to any one room, protecting thus the rooms above and in buildings of the other side of narrow streets. The fire will then burn itself out with small damage. There are several ways in which such screens can be arranged so as to be practically out of sight and therefore entirely unobjectable from the esthetic point of view. The most evident method is the rolling screen counterweighted and provided with fusible clutches above and below, as in Fig. 1. There is also the possibility of the rolling steel shutter on an inclined track as outlined in Fig. 2, or the automatic folding side screen shown in Fig. 3.

Finally there is the scheme shown in Fig. 4, which the writer considers the most desirable, because it is positive in action and can be arranged so as to be practically unnoticeable on the exterior.

With the development of this device the position of the skyscraper from the point of view of fire hazard will be close to impregnable. To require this in New York City would be but to extend the requirements of Sec. 104 of the present building code so that it covers skyscraper conditions

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The Value of the Horsepower has been defined by the U. S. Bureau of Standards for its work as 746 watts, and that figure will be used in future publications of the Bureau as the exact equivalent of the English and American horsepower. Formerly, the work of the Bureau was based on the assumption of 550 ft. lb. per sec. as the correct equivalent at 45° latitude. This gave the inconvenient relation of 1 hp.=745.6494 watts.

The Bureau believes that it is desirable to have the watt and kilowatt used as the units of power wherever possible for all kinds of scientific and engineering work. The physicists of the Bureau also hold that the relation of the watt to the horsepower should be a constant for all places and that the number of foot pounds, or kilogram meters per second represented by the horsepower should be the varying quantity; in this way the energy-time equivalent does not vary. A circular (No. 34) has been issued by the Bureau of Standards, giving a historical outline of the use and development of the term "horsepower," a discussion of English and American equivalents, and the basis of definitions of the horsepower. In this it is set forth that the kilowatt is defined directly in terms of the fundamental units of mass, length, and time, and that it is not an electrical unit only.

Freight House Design and Operation

Cost and Methods of Handling Freight

By W. G. Arn*

The freight service is one of the most important parts of the railway business, and the freight-house is one of the most important features of railway plant, while the handling of freight at terminals represents a large item in the cost of operating the freight service. Improvement in the efficiency and economy of this service involves increased facilities and decreased cost respectively. The introduction of appliances for the mechanical-handling of freight seems a very obvious method of meeting both these requirements, but the peculiar conditions of freight house work (where the movements are diverse and do not follow fixed routes) makes the mechanical handling of freight a difficult problem. The design of the freight-house and the layout of its track facilities are other highly important factors in the problem of combining an increase in facility with a reduction in cost. The article published herewith discusses these several questions, and describes the methods of freight-house work. It gives particular attention to the possibilities of mechanical handling of freight, which is now a subject of very live interest to railway officers, engineers and manufacturers.

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In freight stations in the larger cities the cost per ton for handling outbound freight is entirely out of proportion to the other transportation cost, and runs in some cases to a maximum of $1.50 per ton, almost as much as the average receipts for a 200-mile haul. This expense covers the following items: 1, switching cars into and out of house; 2, handling goods through house from wagon to car; 3, cost of agent and office clerks; 4, a fair return on the land value; and, 5, a fair allowance for interest, maintenance and depreciation on building and tracks. Any material reduction in this expense must of necessity be made in the items of handling and switching, which together cost (in some stations) as much as 50c. per ton. Both of these items depend upon the design of the station.

The cost of handling, however, depends also very largely on the method of moving freight through the house; that is, whether it is moved by the old method of hand trucking, or by such modern methods as motor trucks, telferage systems, or conveyors. The meaning of the term "conveyors" in this article is limited to that ordinarily understood; that is, platform, belt, chain or bucket conveyors.

The hand truck is undoubtedly the most economical method for small stations. Many existing stations can be equipped with motor trucks to effect a material saving in handling. No conveyor has yet been devised which is adaptable to the great variety of goods which must be handled in the ordinary freight station. The telfer, or monorail crane, which has been in use for a number of years in various manufacturing establishments where only one commodity or one class of packages was to be handled, has now been adapted to the diversified needs of a freight station. In the freight station of the Missouri, Kansas & Texas Ry. in St. Louis, all freight is handled by telfers,* thus demonstrating the feasibility of so handling all the varied articles handled by railways in their less-than-car loads freight business.

*Engineering News, June 29, 1911.

The Design of a Freight Station

In this article it is proposed to discuss the principles which should govern the design of a modern freight station, and to submit several designs for such a station. The item of land cost, or value, is of great importance. In some cases it is an impossibility to secure the land necessary on which to erect a station of such size as to give the most economical operating results. In other cases the land may be so expensive that the railway company would not be justified in making the outlay necessary to secure the minimum operating cost. A two-story or double-deck design (Figs. 1 to 3) is submitted to cover such cases. That is, to give a maximum of capacity for a minimum use of ground space. One design submitted (Fig. 4) is for a station which will have the minimum operating expense. A third design (Fig. 5) is for a station where the ground space is not the maximum, where the cost of handling through house will be about the minimum, but where the item of switching will be heavy.

The requirements of the ideal modern freight station may be listed as follows:

1. Economy—The savings to be effected in operation must be such as to at least pay the interest on the increased investment.

2. Minimum Switching—The switching must be reduced to a minimum, to do away with spotting and coupling cars and the consequent delays and damage to both cars and freight.

3. Minimum Handling—There must be a minimum amount of handling of goods from the wagon bed or transfer car to the truck, and from the truck to the outbound car floor. It may be that in handling from business house to station (or *vice versa*) one handling could be saved on many classes of goods by the use of a carrier on wheels. This would be loaded at store or warehouse, pushed onto a wagon bed or frame, hauled to the station, pushed off (or lifted from wagon bodily by telfer) and taken direct to car, pushed into end of car, and then unloaded. All this would be done with only two actual handlings of the goods, except such items as must be weighed or have their weights checked. In some stations the goods weighed may be a small percentage, possibly as low as 10%; while in other cases the proportion weighed may be even as high as 60%. Where a whole carrier load is for the same destination and takes the same rate it can be pushed on the platform scales or weighed on automatic scales in the telfer track.

4. Rapidity.—There must be ability to

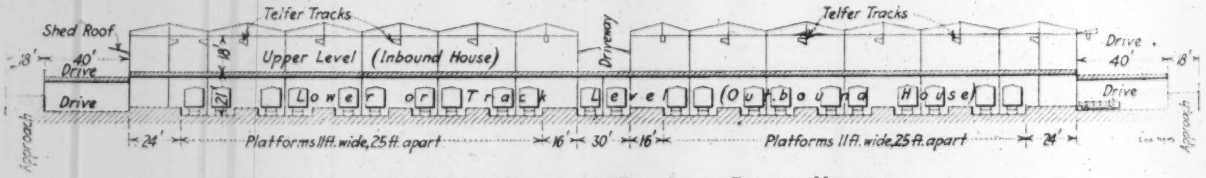


FIG. 1. CROSS-SECTION OF TWO-STORY FREIGHT HOUSE

[Outbound freight (and tracks and platforms) on lower floor. Inbound freight (and telferage system) on upper floor]

handle all the diversified articles which pass through a local freight station for L. C. L. shipments in the least possible time (either minimum distance or with rapid speed and minimum empty haul).

5. Minimum Space—The station must have minimum floor and platform space consistent with economical handling, and utilize this space to the greatest advantage. This means that the space required for trucking be reduced to a minimum, as for instance in a house operated by telfers. However, it cannot be hoped to entirely eliminate floor and platform movements of trucks. Here must be taken into account the fact that much inbound freight is held for one or more days on the floor of the inbound house before it is called for, or before while coupled up, all that is necessary in getting out a train is for a track (or two or more tracks as the case may be) to be pulled and the engine coupled on and the caboose picked up.

B—The cars in which inbound and transfer freight are received are not always available for outbound merchandise loading, sometimes the car itself is not suitable; occasionally one is in need of repairs, and frequently it is a foreign car the home route of which is in another direction from that in which the goods are to be sent.

C—In all stations the outbound cars are given a series of numbers by carding (for instance, from 1 to 300 in a very large station), according to the position occupied. The car for a certain destination is given the same position and card number from day to day. Consequently it would interfere very materially with orderly and efficient handling of freight to have, in a string of cars which has just been unloaded and was to be loaded up for an outbound train, occasional foreign, crippled or unsuitable cars which were occupying needed space and would have to be switched out after the other cars were loaded, sealed and ready to leave terminals.

9. Flexibility in Use of Tracks—This means the ability to use an outbound, inbound or transfer track for cars for either of the other classes, if occasion demands. Also the ability to switch on any track in the station without interrupting work on any other track.

10. Compactness—The whole station (inbound, outbound and transfer business) should be under one roof and on same floor level.

11. Trucking—Ability to vary trucking capacity in proportion to business up to the maximum.

12. Extensions—Ability to increase capacity of station by extensions.

13. Methods of Handling Freight—The station to be so designed that it may be operated by telfers, hand trucks or motor trucks.

HANDLING FREIGHT WITH TELFER SYSTEM

The ordinary method of handling outbound freight from dray to car is as follows: The goods are taken off the dray, checked as taken off, loaded on trucks; trucks pushed on scales and load weighed; truck taken to car and unloaded in car. Or if a large truck is loaded for several cars, the goods for each car are placed on a hand truck or laid on floor

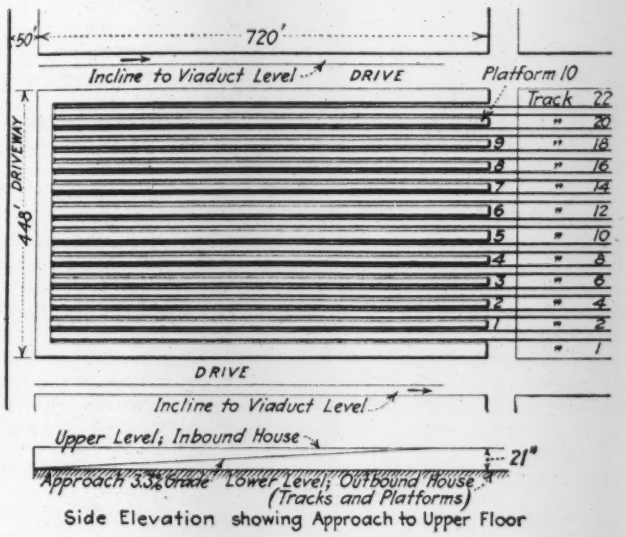


FIG. 2. PLAN OF OUTBOUND FREIGHT HOUSE (LOWER LEVEL)

(No. of tracks, 22; 16 cars (45 ft.) to each track. Total No. of cars, 352. Floor space, 44,160 sq.ft.)

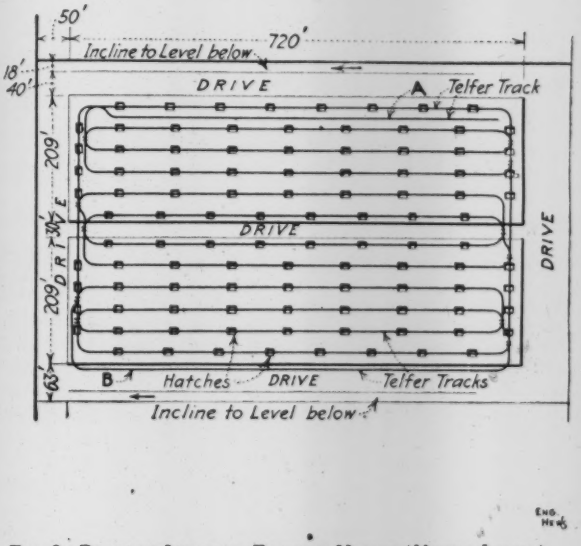


FIG. 3. PLAN OF INBOUND FREIGHT HOUSE (UPPER LEVEL)

(Hatches under telfer tracks, 10x18 ft. Floor space, 255,000 sq.ft. Telfer track A is a storage track for telfers. Telfer track B is for handling heavy articles direct from wagons)

it can be transferred to a storage warehouse and a storage fee charged.

6. Convenience for Drays—The station must be made as convenient as possible to drays, and must avoid unnecessary detention of the drays in delivering and receiving their loads.

7. Handling Steel and Iron—The station should include electro-magnetic hoists for unloading steel and iron products, and possibly also for transferring these products.

8. Unloading and Loading Cars—If cars coming to the station with freight to be unloaded (either inbound or transfer) could be loaded where they are placed for unloading, a big saving in switching and an increased car efficiency could be effected. As a general proposition, however, this would seem to be impracticable for reasons as follows:

A—All cars to be loaded are placed in station order for the train they are to go out on, so that if they can be loaded

at door of car into which they should go and are placed in car by the stowman.

In a case where every package of a load is to be weighed, the truck (carrier) would be placed on automatic scales and weighed, or if all trucks be made to weigh the same, the scales could be set to register zero for the weight of the carrier, then as each package was placed on the carrier its weight could be obtained and recorded. The telfer man would then come along and pick up the carrier, carry it around, and set it at the door of the car in which the goods belonged. The carrier would then be pushed into the car and unloaded as in case of a hand truck, or pushed from car to car, if it held goods for more than one car, leaving at each car's door the goods to go in that car.

With the trucks now in general use (principally hand trucks, but supplemented by four-wheel trucks handled by two men) the average load is about 175

lb. per man. With a telfer system equipped with carriers which will readily enter and turn in a box car (say 3½x5½ ft.) the average load should be raised to 700 lb. for outbound and transfer freight and 1050 lb. for inbound freight, at the space either at the end of the station, or an elevated platform over the tracks, but under the telfer runway for a sorting platform. This has not been included in any of the plans suggested, as it is thought the fixed charges on the extra

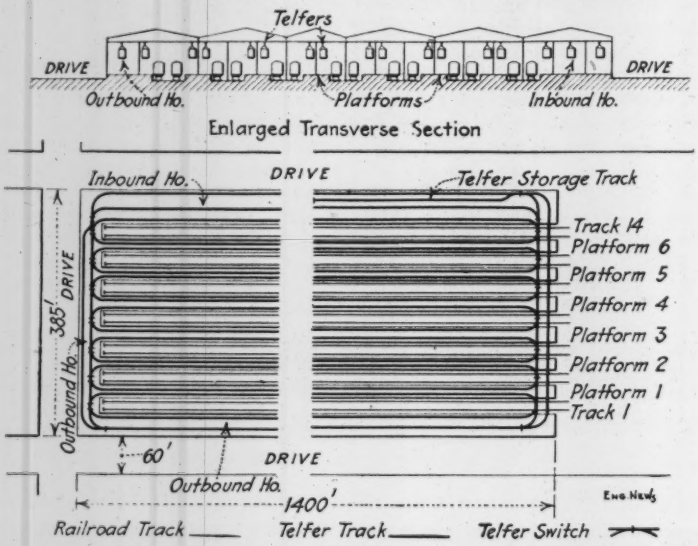


FIG. 4. PROPOSED LAYOUT OF A LARGE FREIGHT STATION WITH TELFERAGE SYSTEM
(Tracks in pairs; capacity, 420 cars)

very lowest figures. This is an increase per movement of 300% in the former case and 500% in the latter. Apparently this saving would be partially offset by the increased distance the freight must be moved. But as the speed of the telfer when in motion may be 1000 ft. per min. on straight track (with an average of half that), while the speed of the man with hand truck is 500 ft. per min. as a maximum (with 250 ft. and probably less as an average), there is in reality no offsetting disadvantage on account of increased distance.

In order to waste no ground space, the platforms between tracks must be no wider than is really necessary. Such a width would seem to be about 18 ft., to give room for two trucks to pass each other while other trucks are also standing on the platform. The goods for peddler cars (cars which have goods for more than one station, to be unloaded by the crew of local freight) must be loaded in station order so that there may be no delays in the local train crew getting it unloaded. Thus, it will frequently be necessary for trucks with goods for certain points to stand loaded outside the car until the goods for stations further along the line have been loaded into the car. As many of the cars loaded at a large station are peddler cars, considerable platform room may frequently be needed for trucks which may not be immediately unloaded into these cars, otherwise the platform width could be made considerably less than 18 ft.

The idea was considered of having a expense of construction, and the expense of the additional handling which would be necessary for such goods as would go to the sorting platform, would be more than the expense of handling such goods by peddler trucks loaded for not to exceed five different cars and preferably for as many cars less than that number as will give a reasonable telfer load.

As the outbound house is merely for receiving and weighing the freight, which should be moved promptly to the platforms, the house may be narrow, 30 to 35 ft. in width being ample. The inbound house should be much wider, as a large part of the goods received is held on the floor for 24 hours, or even 48 hours and longer. In Figs. 4 and 5 the width is 35 ft. for the outbound and 55 ft. for the inbound house.

While it is not hoped to do away entirely with hand trucking, it will be reduced to a minimum. The use of the ordinary two-wheeled hand truck will be dispensed with almost altogether by the use of such a truck as suggested and the layouts proposed. The use of the hand truck will be limited principally to the following work: 1, moving heavy packages from the transfer cars to outbound cars when the distance is short; 2, unloading inbound cars where the cars are on the track next to inbound house; and 3, handling packages which have been sent to wrong cars.

The manual labor involved in the movement of the four-wheeled telfer trucks or carriers will be as follows: loading truck; pushing truck under telfer track after it is loaded, then after truck has been carried by telfer to the proper car, pushing truck into car and unloading it. In the case of some goods which cannot be carried on the regular carrier, but which must be carried in a sling (as pianos), the load can be deposited on a truck at the car door and then shoved into the car and unloaded. Other goods such as long pipe, rods, bars, etc., which are best carried in slings, can be usually deposited with one end at or possibly sticking into the car door so that the material can be readily carried or dragged in by the stowman.

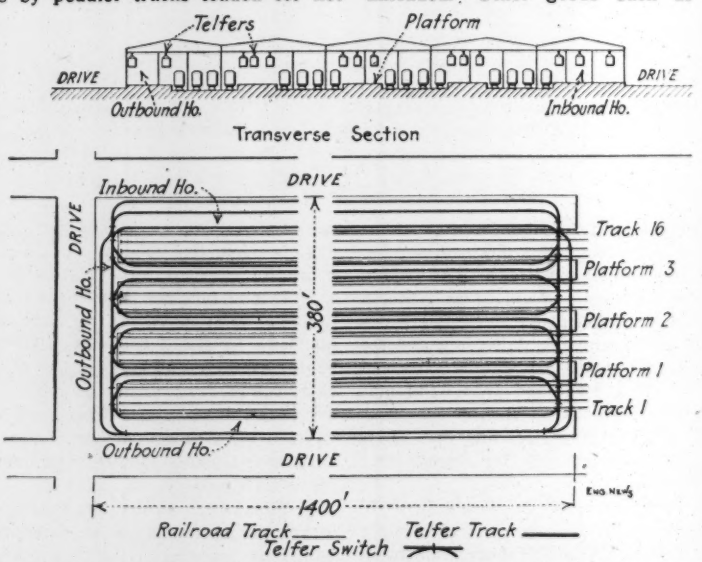


FIG. 5. PROPOSED LAYOUT OF A LARGE FREIGHT STATION WITH TELFERAGE SYSTEM
(Tracks in groups of four. Capacity, 480 cars)

Among the requirements for the telfer equipment are the following: 1, the carriers should be light, ball-bearing, on springs, small enough to push into end of car and capable of being loaded and unloaded with minimum effort. 2, The grapple (apparatus on telfer for taking hold of carrier or truck) should be such as can be operated entirely by the telferman without assistance. 3, The switches in track should be capable of being operated by the telferman while his motor is moving. 4, An extra track should be provided for telfers not in use or those to be repaired.

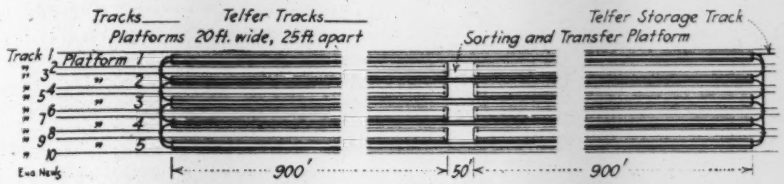


FIG. 6. PROPOSED LAYOUT OF A FREIGHT TRANSFER STATION WITH TELFERAGE SYSTEM
(Stub tracks, in two groups. Capacity, 400 cars)

COST OF OPERATION

In a station in which the business is large enough to require such a plant as shown in the layouts suggested, the cost per ton of handling by the present methods of hand trucking will run about 37c. for inbound and 50c. for outbound freight. The average will be above or below 43c., depending on whether outbound or inbound business predominates. Taking in detail a case where the average cost per ton was 45c., it has been found to be made up as follows (exclusive of the cost of the freight agent and his office force).

	C
Supervision (foreman and assistants)	1½
Clerks receiving, delivery, revising and sealing foreman's (does not include clerks in agent's office)	11
Callers (men who handle goods from dray to truck)	7
Stowers (men who place goods in car)	5
Truckers	20
Miscellaneous (messengers, janitors, coopers, etc.)	½
	45

It is not to be hoped that there will be any material reduction in the cost of any of the items except trucking, and the probability is that at the beginning some of the others will be increased. However, there should be no permanent increase in the total of these other items and the cost of trucking should be cut in two by the construction of a modern station with such a system of mechanical handling, while in addition the cost of house switching should be reduced by more than 50%.

In the case from which the above figures were taken the item of trucking was for 264 truckers whose daily wages amounted to $581. In a station equipped with telfer system handling the same business, the cost per day for trucking would be about as follows:

40 motormen @ $3 per day	$120
Electric current; 25 kw-hrs. per day per machine, 1000 kw.-hrs. at 2½c.	25
Fixed charges: interest, depreciation, repairs, taxes and insurance, assumed as 15% on $306,000 (estimated cost of telfer system) = $45,900 per year, which per day is	149
Total	$294

The business handled in the example is about 3000 tons per day, in which case the cost per ton with telfer would be 9.8c., which is practically half the cost of the present method for trucking. This would mean a saving of $300 per day, or $92,400 per year of 308 working days, or the equivalent of a capital investment of $1,848,000 at 5%.

The saving in house switching (including interest, repairs, maintenance, etc., on engines) would be at least half of the present cost, or a reduction of 1c. per ton. This is an additional annual saving of over $9000, in addition to which is the saving due to avoidance of damage to cars and freight through the jarring attendant upon coupling up long strings of cars. For stations of considerably smaller size the reduction in trucking expense would not be so great per ton, nor even so great a percentage; but nevertheless it would effect a very considerable saving. For any very large station (say 1000 tons per day and upward) the saving in trucking to be effected should be about the percentage shown, that is, 50%.

ARRANGEMENT OF TELFER SYSTEM

The ideal arrangement seems to be that shown in Fig. 4; that is, a U-shaped house with stub tracks. One wing to be for inbound freight, and the other wing and end to be for outbound freight. The tracks to be grouped in pairs with a platform between each two pairs of tracks. The platforms in this design are 20 ft. wide and 25 ft. apart. This arrangement is adaptable to any size of station and is not only best for the telferage system, but for any method of handling. The economy of this layout for hand trucking has been amply demonstrated in the station of the Grand Trunk Ry. at Toronto, and of the Lake Shore & Michigan Southern Ry. at Toledo.* In the latter case, however, the tracks are single instead of in pairs, there being five platforms and only six tracks between the houses.

This arrangement of telfer tracks gives a long maximum and average haul, but it is also such as to give the fewest switches and curves, and to enable a motor on any track to set its truck down in front of the door of any car on that track. Arrangements giving a shorter haul required so many additional curves and switches that the complications, extra cost, slower average speed, etc., were considered as much more than offsetting the disadvantage of the longer haul of the plan suggested. It is intended that as a general rule there shall be no back-up movement of the telfers, the system being so laid out that any point may be reached by a forward movement. Of course, a limited back-up movement is permissible where a motorman can see that he will block no other movement.

Such a station as shown in Fig. 4 should be able to handle economically 6000 tons per day of 10 hours. To do this would probably require 60 motors, each to handle 100 tons per day, or an average of 10 tons per hour. There would be approximately 25,000 lin.ft. of telfer track, and the maximum circuit would be 3600 ft. The maximum haul would be 4600 ft. and the minimum about 50 ft.

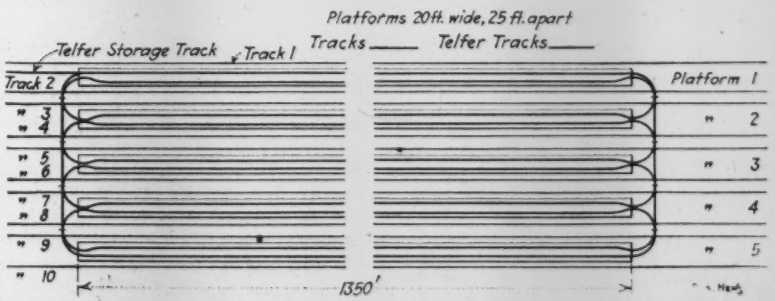


FIG. 7. PROPOSED LAYOUT OF A FREIGHT TRANSFER STATION WITH TELFERAGE SYSTEM
(Through tracks. Capacity, 400 cars)

On account of the fact that much of the inbound freight is unloaded in the morning and most of the outbound loaded in the afternoon, the empty haul will be considerable, as most of the carriers will move empty one way. In order to have as little interference in operation as possible, and to reduce the empty telfer haul to a minimum, it would seem advisable to use only the alternate tracks

*Engineering News, March 25, 1909.

for outbound cars; instead of every track in a group, as is customary in the present design of freight houses. This would leave every second track for transfer or inbound freight, each platform thus being used principally for inbound trucks in the morning and for outbound trucks in the afternoon. Some of the transfer freight would be merely moved across a platform to outbound cars, while much would require only a movement along and across a platform.

This arrangement of cars would give over each platform one telfer track for outbound and one for inbound and transfer. Or if the inbound business was in excess, one telfer track for inbound and one for outbound and transfer. Thus certain motors could handle outbound freight exclusively and others handle inbound, but at any time any motor could be shifted from inbound to outbound business (or *vice versa*) as business demanded. This would result in a minimum interference and probably maximum efficiency. However, if it were found desirable to use the tracks on one side of the house for outbound, those on the other side for inbound and the middle ones for transfer cars, there would be nothing in the design to interfere with such an arrangement.

Fig. 5 is an alternative design, with tracks in groups of four, instead of in pairs. Here the platforms are 30 ft. wide and 50 ft. apart. A comparison of the two designs is given in the accompanying table.

FEATURES OF ALTERNATIVE DESIGNS OF FREIGHT HOUSES

	Tracks in Pairs	Tracks in Sets of Four
No. of cars	420	480
No. of railway tracks	14	16
No. of telfer tracks	17	14
No. of platforms	6	3
Length of platforms	1400 ft.	1400 ft.
Width of platforms	20 ft.	30 ft.
Width between platforms	25 ft.	50 ft.
Floor space, sq.ft.		
Outbound house	60,500	60,500
Inbound house	77,000	77,000
Platforms	163,800	122,800
Team frontage, lin.ft.		
Outbound house	1,600	1,600
Inbound house	1,260	1,260
Platforms	None	None

Transfer Stations

For a station handling only outbound freight two designs are given in Figs. 6 and 7. In the former (Fig. 6) there is a transverse sorting platform in the center, about 50 ft. wide, with long narrow platforms (20 ft.) extending at right angles to it. Between these latter are the tracks in pairs with stub ends against the 50-ft. cross platform. Each alternate track is to be used for empty cars ready for loading; the track just across the platform is to be used for the loads which are ready for transferring. Each track should be long enough to hold the cars making up one outbound train, except where the tracks would be too long, under which circumstances they can be made the length of half a train. Such an arrangement, while making a long station and covering considerable ground, seems to provide a station where the operating expense would be a minimum. As transfer stations are usually built well outside the large cities, the cost of land is comparatively a small item of expense, so that the area of ground occupied is not as important as in the case in the city freight station.

In the second plan for a transfer station (Fig. 7) there are no stub tracks and no cross platform. Each track runs through the station and is connected at each end to the yard tracks. Here also are narrow platforms, between and parallel with which are tracks in pairs. The platforms in both cases are 20 ft. wide and 25 ft. apart. The advantage of this latter plan (Fig. 7) over the first is that it does not extend over so much ground in order to give the same number of cars in a cut, and the maximum telfer distance is only about half, although the average would probably be little shorter.

As the cost in many transfer stations operated by hand is 20c. (or less) per ton, it is not claimed that any lessening of cost would be effected by installing a telfer system in such a station. But where the cost is above 20c. per ton, a material saving should be possible, besides which the capacity of the station would be increased.

Telfer Design

In telferage systems there are two forms of the so called monorail crane, or motor hoist, each having certain advantages. In one, the wheels are double-flanged and run on top of a single T-rail on top of an I-beam; in the other, the wheels run on two T-rails, one on each bottom flange of the I-beam. This latter is, therefore, in reality a two-rail track, the wheels of the telfer carriage having flanges on the inside only. The former has the advantage of fewer wheels and wearing parts. The latter is better balanced and probably capable of higher speeds and greater safety on curves, though some manufacturers of the former make the claim of higher speeds for their cranes.

If the use of the telferage system becomes general, it may lead to the development of a new style of box car; from which a section of the roof can be removed, so that loads may be deposited on or taken directly off the car floor. Such cars would be particularly adapted to L. C. L. business and to certain classes of carload business.

The Best Steamshovel Record yet made on the Panama Canal is that of shovel No. 257 working in the west borrow-pit for the Gatun dam for the month of August. The month's total excavation for this one shovel was 86,844 cu.yd. of earth and rock, the highest total for any steamshovel since the beginning of the canal construction.

The Thermal Conductivity of Carburizing Materials

By J. H. Nead* and J. N. Bourq†

Because of the increased use of carburized or case-hardened parts, in modern machine construction, a considerable amount of investigation has been carried out during recent years on various phases of this subject. The writers themselves have conducted extensive researches dealing with: first, the efficiency of certain commercial carburizing compounds as to (1) physical condition; (2) chemical composition; (3) shrinkage during use; (4) degree of carburization (both depth and carbon content) under constant conditions; (5) effect of repeated use; and secondly, the effect of temperature on the depth and the rapidity of the carburizing operation. The present report has to do with a branch of the subject which has as yet received very little or no attention from other investigators, yet which necessarily plays a most important rôle in economic and successful carburization.

Object of Test—The object of this experiment was to determine the relative rapidity with which different carburizing materials would heat up. This factor is of great practical importance in determining the length of time required for the carburizing operation, inasmuch as previous experiments have shown us that, using a standard round carburizing pot 9 in. in diameter and 15 in. high, more than two-thirds of the total time required to attain a depth of $\frac{1}{32}$ in. of case under regular carburizing practice is required in heating up the pot and contents to the carburizing temperature. This is, of course, using a raw bone as a carburizing medium. It will be readily seen that a saving in time in bringing the contents of the pot up to heat will materially decrease the cost of the carburizing operation.

Procedure—The materials used in conducting this experiment were:

"Material B"—An ordinary grade of raw bone as supplied by a rendering company.

"Material H"—An intimate mixture of soft coal, soda ash and limestone, coked and crushed to convenient size.

"Material P"—A mixture of powdered charcoal and barium carbonate in approximately the proportions 40 to 60 parts by weight.

"Material R"—Consisting of powdered charred bone and barium carbonate thoroughly mixed.

"Material S"—An intimate mixture of powdered charred bone and crushed charcoal.

"Material I"—Ground charred bone

*Metallurgist, The H. H. Franklin Manufacturing Co., Syracuse, N. Y.
†Metallurgist, The Brown-Lipe-Chapin Co., Syracuse, N. Y.

8/10 C. 386 HB. 1 lc., 1 t. Set 10-22 impregnated with about 25% of a hydrocarbon oil.

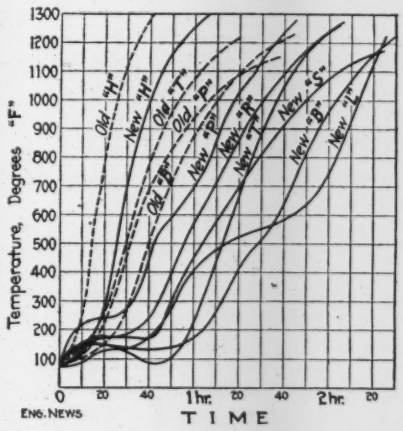
"Material T"—A special mixture having as a base charcoal and a calcium saccharate.

The materials were obtained as samples of commercial carburizing materials from various manufacturers. The method of carrying out the experiment and the general set-up are described below.

The plan was to heat a lead bath to a constant temperature and to record the time for a thermo-couple in a special pot to come up to some definite temperature, the pot to be packed with the different carburizing mediums. The lead pot was 24 in. long, 15 in. wide, and 7 in. deep, and was filled with lead to a depth such that when the pot containing the carburizer was immersed in it the lead stood within ½ in. of the top. The temperature of the lead pot was recorded by a calibrated Le Chatelier thermo-couple. The lead pot was covered by a sheet of steel ¼ in. thick and contained holes to accommodate the carburizer pot and thermo-couple tube. The pot for containing the carburizer was made of 6-in. round pipe of ¼-in. wall, and 8½ in. high. A plug ¼ in. thick was welded in the bottom. Angle-iron handles were riveted to opposite sides by means of which the pot was held down in the lead bath. The handles were so located that they held the pot immersed to a depth of 5½ in. in the lead. The temperature of the inside of the pot was recorded by a calibrated Le Chatelier thermo-couple so located that the hot junction was equidistant from the bottom and sides of the pot. Both thermo-couples were connected up to read on a Paul single-pivot galvanometer through a double-throw switch. The temperature of the cold junction of the couples was recorded.

In packing the pot with the different carburizing materials it was filled up level full, after properly locating the thermo-couple, and then tamped fairly tight. The pot was covered with a thin sheet-steel cover containing a hole for the thermo-couple tube and this cover was luted on with clay. Records were taken, at the time of putting the packed pot in the lead and every five minutes thereafter, of the pot and lead temperatures until the pot temperature reached 1200° F. The temperature of the lead was controlled as close as possible to 1425°. The recorded temperatures were corrected for cold-junction temperature and the calibration error; and time-temperature curves were drawn for all the compounds used.

RESULTS—Curves plotted from the observed data are seen in the accompanying figure. A consideration of the data and curves will show that the slowest material in heating up is raw bone, which is most likely due to the high percentage of moisture and volatile matter contained. Once-used bone is considerably faster than the new or raw bone. The fastest heating material was once-used "Material H," and the next fastest was new "Material H." The length of time required for these two carburizing materials to come up to a temperature of 1200° F. is as follows:



RESULTS OF TEST ON THERMAL CONDUCTIVITIES OF CASE-HARDENING MATERIALS

New B	2 hr. 25 min.
Old B	1 hr. 34 min.
New H	52 min.
Old H	33 min.

Considering the new "Material H" as against new or raw bone, there is a saving in time of coming to heat of 63%, and considering old "Material H" against old bone there is a saving of practically the same, 65%.

Considering the fact that two-thirds of the time required for carburizing is spent in bringing the entire pot to the proper carburizing temperature, the adoption of "Material H" as a carburizing medium will effect a saving of fully 30% on the cost of fuel for this operation.

Considering the data in regard to the other materials used in this experiment, it will be seen that they all fall between new "Material H" and raw bone in regard to the length of time to come to 1200° F. The curve for "Material L" is very interesting in that it shows a very marked slowing up in the heating at a temperature of about 550° F. This material consists of a ground bone impregnated with a mineral oil to the amount of about 24% by weight, and the irregularity in the curve noted above is undoubtedly due to the volatilization of this oil, a very noticeable amount of heat being required for the purpose. The addition of this oil is a detriment rather than a help to the material, for it causes a useless waste of heat and the user pays for a material which is entirely useless for carburizing purposes.

This experiment has served to place the different carburizing materials in a definite order in regard to their rapidity of heating up to carburizing temperatures, as shown in the accompanying table.

The authors wish to acknowledge their thanks to M. T. Lothrop, formerly of the Halcomb Steel Co., for helpful suggestions.

THERMAL CONDUCTIVITY OF CARBURIZING COMPOUNDS

No.	Name	Price per ton	Lb. per Cu.ft.	Time to Heat to 1200°F.	Percent. of Fastest	Percent. of Slowest
1	Material H new	$60.00	28	52 min.	153	34.7
2	Material H old	60.00	28	34 min.	100	22.7
3	Material B new	57.00	52	145 min.	425	96.5
4	Material B old			99 min.	291	66.0
5	Material P new	90.00	35	96 min.	282	64.0
6	Material P old			110 min.	324	73.5
7	Material T new	40.00	51	114 min.	336	76.0
8	Material T old			76 min.	223	50.5
9	Material R new	80.00	45	112 min.	330	74.5
10	Material L new	40.00		143 min.	424	95.5
11	Material S new			150 min.	442	100.

A Research Corporation for Promoting Scientific Investigation—In Engineering News of Oct. 26, 1911, the precipitation of smelter fumes was described as developed by Prof. F. G. Cottrell, then of the University of California but now Physical Chemist of the U. S. Bureau of Mines. In our issue of Oct. 3, 1912, the application of the process to the elimination of dust from portland-cement plant stacks was noted. The patent rights for this precipitation process, except for those in six Western States and for the cement industry, have been turned over to an organization known as the Research Corporation, which was organized to administer this and any other similar donations. The stock is non-dividend paying, $100 par, and so far has been issued in lots of one to three shares among the following subscribers: Charles Kirchoff, B. B. Lawrence, A. D. Little, Hennen Jennings, James Douglas, T. C. DuPont, Cleveland H. Dodge, E. D. Adams, F. A. Goetze, E. H. Hooker, T. C. Meadows, H. C. Perkins, C. A. Stone, J. J. Storrow, Elihu Thomson, H. R. Towne, and C. D. Walcott. It is expected that the payments of these subscribers will cover the expenses of the corporation until it is self-supporting.

Mr. Cottrell proposed at first to give to the Smithsonian Institution of Washington all rights to his own inventions in the condensation of smelter fume, except for the states noted and for applications to the portland-cement industry. The institution, however, found it not desirable to become the owner of royalty-bearing gifts. The Research Corporation will administer other patents donated or purchased, and it is hoped that the surplus revenues will be sufficient to permit the advancement of research work by schools and societies. The corporation has offices at 63 Wall St., New York City.

The Training of Sanitary Engineers*

BY GEORGE C. WHIPPLE†

Within the last quarter century a new profession has come to the fore—sanitary engineering. It represents the application of a new science to a new product of civilization. The new science is Bacteriology; the new product of civilization is The Modern City.

How important sanitary engineering is to the world today is scarcely realized, so gradual has been its evolution, but its importance may be appreciated by comparing the conditions of life in our cities today with the conditions that existed in ancient days, or even a few generations ago.

The world has always had its cities. Man is a gregarious animal. The cities of long ago developed to their limit and then fell into decline, and in many instances disappeared altogether. Sometimes they were destroyed from without by their enemies; sometimes they fell victims to the cataclysmic forces of nature; but often they fell from more insidious causes: from diseases that swept through their inhabitants until great aggregations of people were reduced to mere handfuls, and those that remained were scattered through fear and starvation.

Two potent factors limited the growth of ancient cities: lack of transportation, and ignorance of what constitutes hygienic environment. Without adequate transportation the food of cities was limited to local supplies. If these failed famine followed and the people fled to where food could be found. Coast cities could receive supplies by water and some of the old maritime cities long maintained their supremacy, but large inland cities as we have them today were formerly unknown. Without knowing how to control transmissible diseases, with no better theory than that they represented the visitation of an angry Providence, no wonder that famine was followed by pestilence, and that as cities became more crowded, the wider was the spread of the dread calamity.

Our modern cities, far greater in number and size than ever in the world's history, are made possible first, by the development of transportation by road and rail and fast steamships, so that food from afar may be brought to the homes of the urban dwellers; and second, by the development of the arts of sanitary engineering, by which the people are supplied with pure water and pure air, and the waste products of life safely and inoffensively removed. Other influences, of course, have contributed, but among them all the work of the sanitarian is conspicuously successful and conspicuously modern.

To give a simple, adequate definition of sanitary engineering is difficult. From an early application to plumbers and expert drain layers, the term has grown in importance as the works have grown in magnitude, until it now includes civil engineers engaged in providing public water supplies, sewerage systems, garbage-disposal works, methods of cleaning streets and draining swamps, as well as engineers whose interests are chiefly indoors and who are engaged in providing systems of plumbing and ventilation for buildings. If the civil engineer be defined as "he who adapts the great forces of nature for the use and convenience of man," the sanitary engineer may be correspondingly defined as "he who adapts the forces of nature to the preservation of the public health, through the construction and operation of engineering works."

The problems of the sanitary engineer are so vast and so varied, they bring him into contact with so many branches of science and with so many classes of people that an exceptionally broad education is demanded. Engineering is fast coming to be regarded as one of the learned professions, and the education required of one who enters this profession must be not only scientific and technical, but broad and humanitarian. He must not only know the underlying principles of the mechanical sciences, but if he is to become the director of great enterprises he must have the power to think logically and reach conclusions quickly, write clearly and speak forcibly—not to mention such moral qualities as honesty, enthusiasm, and that vague something termed "personal magnetism." Some of these qualifications are inherent in the individual; some come with experience; but the power to think and speak and write can be acquired by study and practice. It is partly because of this need for broad-minded engineers and partly because science itself is becoming so broad and its branches so interwoven, that the applied sciences are being taught more and more as graduate courses in our universities, and that the technical schools are looking forward to longer courses than the usual period of four years. This need of an extended education is particularly true of sanitary engineering, for more than some of the other branches of engineering, it requires the aid of many sciences. Not only must the sanitary engineer be versed in mathematics and mechanics, but he must have a working knowledge of parts of chemistry, biology, bacteriology, microscopy, meteorology, geology, hygiene, preventive medicine, vital statistics. Unlike other branches of engineering, sanitation is concerned not alone with iron and stone and other inert building materials, but with organic matter and living things. The purification of water and sewage is due largely to biological action, and the knowledge of bacterial processes is scarcely less important to the sanitary engineer than that of the laws governing the flow of water in pipes and the strength of materials.

While this is acknowledged, it is also true that first and foremost the sanitary engineer must be an engineer, and the collateral sciences must be subordinated. Hence, the student must be trained primarily in engineering, and secondarily, in sanitation. The emphasis is important. It cannot be successfully reversed. Sanitary science teaches the student why this or that structure is needed, but it does not teach him how to design or how to construct, and these are for him the very fundamentals of his profession. The wisely arranged curriculum will, therefore, cover the field of sanitation in a broad and general way, without taking too much of the student's time from his detailed studies in structures and hydraulics.

But sanitary science is becoming so important that there is room not only for the constructing engineer, but also for the sanitary specialist, and for him whose duty it is to operate the works after they are built; to take charge of the water filters and the sewage treatment plants, to manage the garbage works and superintend the cleaning of the streets and buildings. Such men need a slightly different training from the others, and the ideal course would give less attention to civil engineering features and more attention to mechanical engineering and laboratory work. Also more attention should be given to the subject of accounting and scientific management. This need for capable managers of sanitary works will soon be a pressing one and our technical schools must be prepared to furnish men for this service.

Besides the sanitary engineer and the specialist in sanitation, the world today needs—and the need is very great—a kind of man just beginning to make his appearance, namely, the sanitary executive, or, as he is more often called, the health officer. There are already many so called health officers serving on boards of health or employed by them. Some of these men are great leaders, well worthy of the honorable positions they hold, but the rank and file of them are ill-fitted for their important task. Our public-health machinery was installed when the hygienic wisdom of the town was wrapped up in the family doctor and when the physician was the logical custodian of the public health. With the growth of the science of bacteriology and preventive medicine and the application of engineering, all this is changed. The

*A paper read before the International Congress on Hygiene and Demography, Washington, D. C., Sept. 25, 1912. Some papers on the education of health officers before the same Congress, were abstracted in our report of the Congress, published in our issue of Oct. 3, 1912.

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ability to diagnose a case of smallpox and keep a record of deaths is no longer a sufficient qualification for the health officer of even a village, while the growth of our cities is making it increasingly necessary that the men in charge of the public health of so many people shall be experts in their line.

Medical training alone does not fit men for this service. The problem of curing disease is quite different from the problem of preventing disease. The former deals with human beings as individuals; the latter considers them as units of a mass. The prevention of disease involves mathematics; statistics relating to the sick and the dead must be constantly and daily used in order to show what forces of disease are at work, and where the attack is next likely to be made. It involves engineering; for the public must be protected against impure air and infected water, and streets must be cleaned and garbage removed. It involves chemistry; for the public must be protected against the sale of adulterated and poisonous foods. It involves bacteriology; for infectious diseases must be diagnosed and antitoxines provided. It involves law; for the health officer must be able not only to discern evils but to eradicate them. But the duties of a health officer should not be entirely repressive and punitive. There is a positive side. His department should be an educational force in the community, constantly instructing the people in the arts of hygiene and in the principles of right living. Many believe that this educational function of the health officer is one of the most important of his duties.

In the pursuit of the elements of sanitary science, the sanitary engineer, the sanitary specialist and the health officer meet on common ground, and to a certain extent their education may be appropriately conducted together. But for the most part their work, although mutually helpful, lies apart, and their education in the main should follow separate channels. The health officer needs his special work in the study and control of diseases, in the use of vital statistics, and in other subjects that tend to fit him for an executive. The sanitary specialist needs extensive laboratory experience and practice in research, while the engineer needs to work with his surveying instrument, his drafting board and the other tools of his profession.

As an illustration of modern tendencies in the training of sanitary engineers mention may be made of the newly established courses in the School of Engineering, Harvard University.

Here sanitary engineering does not lead to a special degree, but is considered as a branch of civil engineering—in fact, all students in civil engineering are expected to take the general course in this subject. The same course is also open to candidates for the degree of Doctor of Public Health in the medical school. For those who intend to engage in sanitary work at once after graduation, courses in Water-Supply Engineering and Sewerage Engineering are offered during the last term, and in these the students receive such detailed instruction as will fit them for the actual kinds of work that will be expected of them in practice. This instruction is not given as class-room exercises but as individual work, carried on as it would be in the office of a practicing engineer. Much, too, is made of the study of actual works in operation for the benefit of those who intend who intend to enter this field. The extent to which specialized subjects in sanitary engineering should be taught is a difficult matter to decide.

Generally speaking, experience has shown that specialization in our technical schools has been carried somewhat too far. In the writer's opinion it ought to be carried only far enough to incite the permanent interest of the student and enable him, on graduation, to take up some particular line of work intelligently, and with such a degree of skill that he can earn a reasonable income during the early years in which he is getting his real experience in his chosen profession. In later years it is the effect of his general studies rather than of his special studies that make for his success. In other words, it is mental culture, after all, that counts.

One feature of interest in connection with the Harvard School of Engineering is the fact that it continues through the entire year, utilizing the time usually devoted to the long summer vacation. This enables the student to accomplish his engineering studies and obtain his Master's Degree in two full years after receiving his Bachelor's Degree. The summer work is of particular advantage in the study of certain phases of sanitary engineering, as it enables field work to be carried on at a season when the biological processes are at their maximum, and when material for study is readily available.

From the Harvard School of Engineering, one of the latest to take up this field, let us turn to the Massachusetts Institute of Technology, a pioneer in American sanitation. Since 1889 nearly a hundred men have taken the Bachelor's Degree in Sanitary Engineering, and many other graduates in civil engineering, chemistry and biology have taken up sanitary work. The influence that these men have had on the public health of our country cannot be measured, but the lives that have been saved by the works they have built are numbered by thousands, and by these works our cities are being made cleaner and better and safer places in which to live. The American cities owe a debt to the Massachusetts Institute of Technology and the other universities that they can repay only by their most cordial and generous support.

Sanitary engineering is yet in its youth. Its practice is far from being crystallized. More than other branches of civil engineering, therefore, it demands research. Half a million dollars has been spent in this direction by our states and municipalities, but the research carried on by our universities has not been as great as might be expected. Additions to university funds for this purpose would bring important results. Immense sums have been given as endowments for research in the cure of disease and in preventive medicine. But it has hardly yet become realized that the great life-saving agencies are carried out by engineers, and that by improving the engineering arts vast sums of money may be saved.

Our country is justly proud of the work of the United States Government in preventing disease at the Isthmus of Panama, and in showing how the tropics may be safely inhabited by white men, but this work has been very expensive. The next step in advance is for the sanitary engineer to accomplish the same task at greatly less cost. This step is absolutely necessary. Research in sanitary economy is, therefore, one of the directions in which money may be well spent during the next decade.

The demand for young sanitary engineers is continuous and increasing. There is little doubt but that men who enter this field will find useful service and a competent livelihood. This is ample reason for a young man to study this subject. But there is another reason inherent in the training itself. A piece of iron to be welded into a useful tool or a thing of beauty must be heated white hot and then hammered into shape. So a student must be first inspired until his enthusiasm glows; then he must receive the blows that will shape his mental processes so that they will follow naturally along the track of sound logic and sane thinking. No better combination exists for producing this result than the inspiration to be derived from the wonderful prospect of a world saved by sanitation, and the hard mental work required of him who would be a sound and competent engineer.

V-notch weirs have been adopted for measuring the flow of boiler feed water in connection with feed water heaters by the Harrison Safety Boiler Works of Philadelphia. In order to accurately calibrate these weirs a special apparatus has been erected at the company's branch works at Norristown, Pa. The apparatus consists of two calibrating measuring tanks fitted with a tipping trough for filling alternately. The capacity of these tanks is sufficient for calibrating heaters with a capacity of 300,000 lb. of water per hour. The company guarantees these V-notch weirs in connection with the automatic recording instrument supplied with them to register the flow of water with an error not exceeding 1½%.

A New Variable Speed Hydraulic Power Transmission Device Applied to a Motor Truck

A problem which has, for many years, enticed inventors, engineers, and makers of self-propelled vehicles, has been that of designing a variable-speed hydraulic power-transmission gear for use on such vehicles.

The essential elements of such a device are very simple. It is only necessary to connect the driving motor to a pump, to pipe the water delivered by the pump to a hydraulic engine, and pipe the water discharged by the engine back to the pump, and to provide means whereby the pump may vary the quantity of water delivered, while its driving motor runs at constant speed, and the apparatus is complete.

But it is quite another matter to devise an apparatus of this sort which will be, not only mechanically operative, but commercially practicable, and inventors by the dozen have given up the task, after patience and funds were exhausted. One of the elements essential to success, for example, is high efficiency. If this is not attained the frictional loss will reappear as heat in the power-transmitting liquid. The temperature of this liquid will rapidly increase, until the point is reached where radiation loss will equal the heating effect, and this temperature may be so high as to make the device impracticable. In the early days of the Westinghouse Electric Co., when a variable-speed gear for electric street cars (at that time equipped with low-powered motors) was considered very important, a variable-speed hydraulic gear transmission of the turbine type was worked out and tried, with the result that the water used in the transmission promptly reached a boiling temperature.

Experience since that day in the construction of hydraulic brakes has made it clear that very high speed has its drawbacks in hydraulic power transmission.

Besides the necessary high efficiency a hydraulic transmission gear, to be available for use on motor vehicles, must be compact enough to admit of installing it in the limited space available; it must be rugged enough to stand the shocks that the service involves, and light enough that its weight shall not seriously reduce the loading capacity of the car; and, of course, it must be made and sold at a price not in excess of what the results it gives are worth to the user.

The variable-speed hydraulic transmission apparatus which is herewith illustrated, is not wholly new in principle. Early patents were taken out by H. F. J. Porter, of New York City, on a device which embodied some of the same ideas upon which this gear is constructed, and which found a useful field in turning the turrets of battleships.

It was particularly desired, however, to apply the system to the driving of motor vehicles, and a much lighter and simpler machine was desired. The task of undertaking its production was assumed by Charles R. Pratt, and the whole development was put in charge of the Universal Speed Control Co., of 19 Liberty St., New York.

This gear consists, as shown in Fig. 1, of a reciprocating, multi-cylinder, rotating hydraulic pump, single acting and direct connected to the shaft of the driving engine, and of two reciprocating, multi-cylinder, rotating, hydraulic motors, single acting, operated by the pump, and direct connected one to each of the chain-drive sprockets, as shown in Fig. 2. These three units are inclosed in a sectional, cast-iron, air- and water-tight case, as shown in Fig. 5, which is attached to the framework of the chassis at three points, as shown in Fig. 2. This case serves to protect the working parts against physical injury, and also against the weather, and serves as a heat-radiating surface. The working fluid is ordinary machine oil and besides serving in that capacity, it is used as a lubricant, the gear case being entirely filled with it, so that all moving parts operate submerged in oil. Thus the working fluid provides the most perfect possible lubrication for all the moving parts, and in the simplest manner, while the whole apparatus is preserved from corrosion.

The pump element and the two motor elements of the gear are very similar in

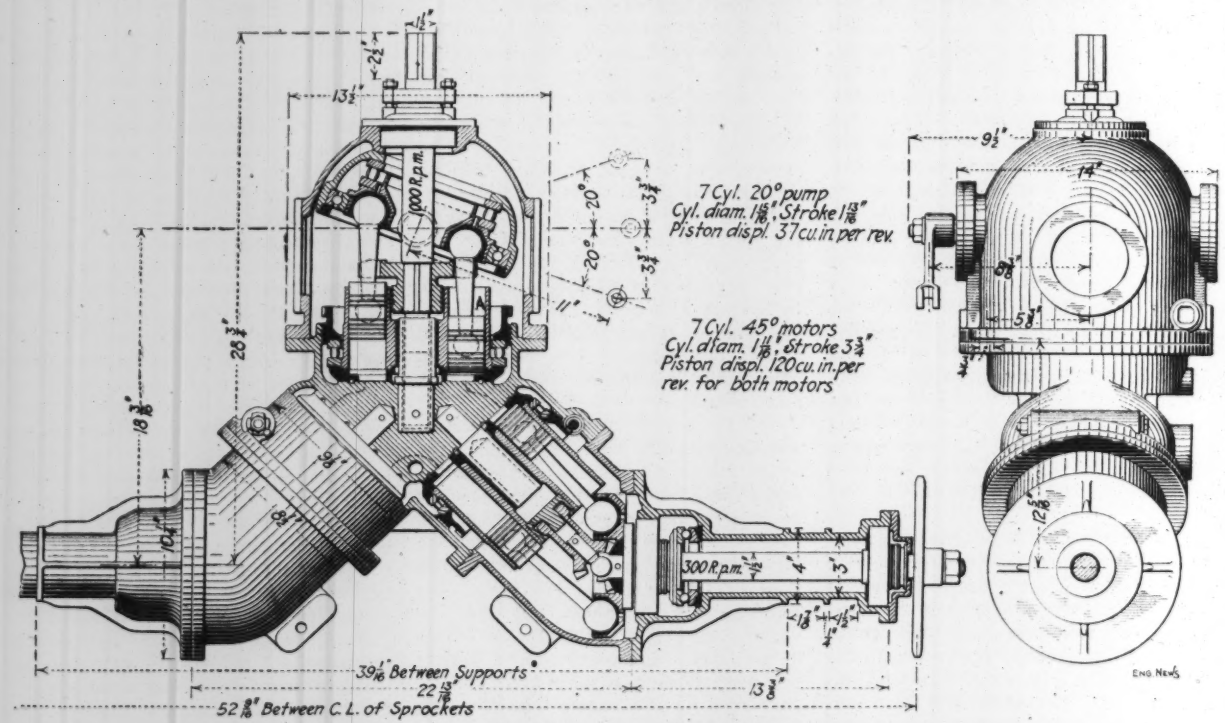

7 Cyl. 20° pump
Cyl. diam. 1 15/16", Stroke 1 13/16"
Piston displ. 37 cu. in. per rev.
7 Cyl. 45° motors
Cyl. diam. 1 11/16", Stroke 3 3/4"
Piston displ. 120 cu. in. per rev. for both motors
1000 R.p.m.
300 R.p.m.
39 1/16" Between Supports
22 13/16"
13 3/8"
52 3/16" Between C. L. of Sprockets
ENG. NEWS

FIG. 1. SECTION OF VARIABLE-SPEED, HYDRAULIC POWER TRANSMISSION GEAR, MADE BY THE UNIVERSAL SPEED CONTROL CO. OF NEW YORK

design, construction, and operation. All three have rotating cylinder barrels, containing a number of cylinders of equal length and equal bore, arranged symmetrically with regard to the axis of the barrel and with their axes parallel to and

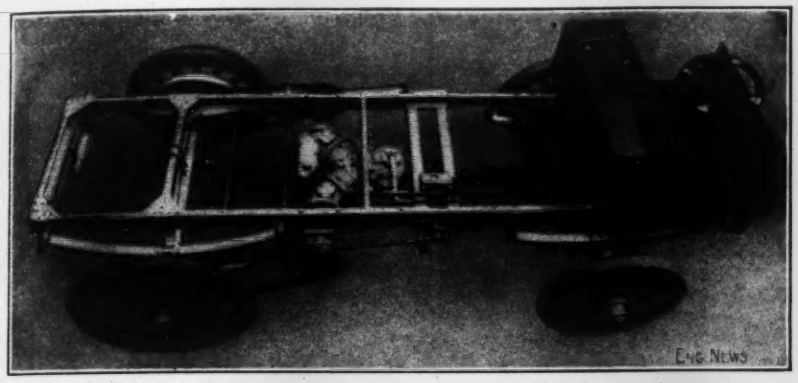


FIG. 2. TOP VIEW OF VARIABLE-SPEED HYDRAULIC POWER TRANSMISSION GEAR, MOUNTED ON AN AUTO-TRUCK CHASSIS

equi-distant from its axis, as shown in Fig. 4. In these cylinders cast-iron plungers operate, having besides the rotating motion about the axis of the cylinder barrel, a reciprocating motion in the cylinders, parallel to the axis of the cylinder barrel, which motion is caused by the fact that the axis of rotation of the drive head—hereafter mentioned—is at an angle with the axis of rotation of the corresponding cylinder barrel. In each unit the plungers are direct-connected by means of short rods to a rotating drive head. The main points in which the pump differs from the motors are, as shown in Fig. 1: (1) The axis of the pump cylinder barrel coincides with the axis of the shaft of the driving engine, while the axis of each motor cylinder barrel is at an angle of 45° with the axis of the corresponding driving sprocket; (2) the drive head, holding the pump piston rods, is rotated by means of a drive plate, fastened to the shaft of the driving engine, and notched to receive the piston rods, and also the drive head of the pump is so constrained that it rotates about an axis at an angle with the axis of the driving engine shaft, arrangement being made for the variation of this angle from $+20°$ through zero to $-20°$, whereas the drive head, holding the piston rods of each motor, is fastened to the shaft of the corresponding driving sprocket, with its axis of symmetry and rotation coincident with that of the shaft and fixed; (3) the full stroke of the pump pistons is shorter than that of the motor pistons and, by variation of the angle between the axis of the driving engine shaft and that of the pump drive head, the length of stroke of the pump pistons can be varied from zero to full stroke, while the stroke of the motor pistons is of fixed length; (4) the cylinder barrel of the pump is fastened directly to the shaft of the driving engine, while the cylinder barrel of each motor rotates on a fixed post and is connected, through a small bevel gear, to the shaft of the corresponding driving sprocket.

An analysis of the structural and operating features of the device shows them to be built up around these four basic ideas.

1. The combination of pump and motors gives somewhat the same action as a universal joint, insofar as it provides a positive connection between two shafts, rotating about axes at an angle with one another, but without involving the undesirable features of the ordinary universal joint.

2. The working fluid being practically incompressible, and the pump and motor elements having a positive action against it, the fluid forms as positive a link in the power transmission system, between the driving engine and the truck wheels, as if it were a solid rod.

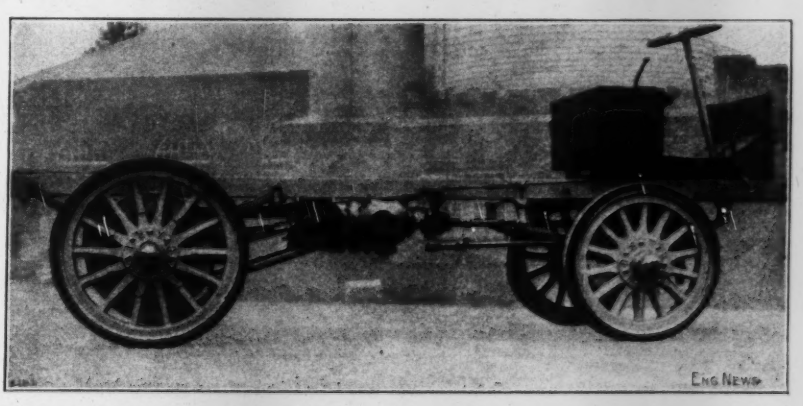


FIG. 3. SIDE VIEW OF VARIABLE-SPEED HYDRAULIC POWER TRANSMISSION GEAR, MOUNTED ON AN AUTO-TRUCK CHASSIS

3. The speed of each motor is directly dependent upon the speed of the pump (not the rotative speed, but the capacity of liquid delivery) and upon the speed of the other motor. This follows from the fact that the capacity of the pump, in volume of liquid handled in a given time, must be the same as the combined capacities of the motors for the same time, because the working fluid flows in a closed circuit and under approximately constant pressure, of amount corresponding to the load. Incidentally it may be well to call attention to the fact that the capacity of each element is the product of its speed of rotation multiplied by its piston displacement, as one revolution of each means a complete working cycle of its pistons.

As the motors are symmetrically placed with regard to the pump and to the supply of working fluid, and as they have the same fixed piston displacement, they tend to have the same speed, its value depending on the capacity or quantity of this fluid handled by the pump at any given time. But if one motor becomes retarded or locked, and the pump capacity remains constant, the other motor is forced to speed up sufficiently to make up for the reduction of speed of the first one, in order that the necessary condition above mentioned may be fulfilled, namely, that the combined capacities of the two motor elements must at any time equal the capacity of the pump element. Incidentally it can be readily seen that the pressures on the two motors will be the same, whether their speeds are the same or not, because they are both supplied through similar ports and from the same source. So the torque on both driving-sprocket shafts will be the same for a given load, regardless of the speed of rotation of each shaft. This whole phenomenon is known as a differential-speed, constant-torque effect and, for reasons referred to below, is very much desired in a device of this kind, for the service it has to render.

4. The element of speed variation is provided in two ways in this gear, each method being absolutely independent of the other, positive in its action, and at the same time capable of simultaneous action in connection with the other method.

Firstly, the speed may be varied, within wide limits, in the same way as in other cars with the usual type of transmission gear, by keeping the gear in a fixed position and controlling the quality of the mixture fed to the driving engine. Secondly, with the driving engine at constant speed, the speed of the car can be varied from full speed ahead, through zero, to full speed reverse, by variation of the angle between the axis of rotation of its piston casting and that of the drive shaft, thus varying the length of stroke of its pistons, and so varying its piston displacement.

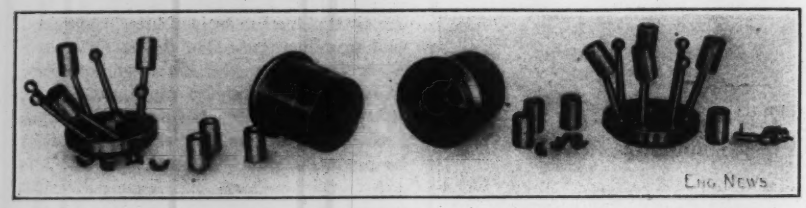


FIG. 4. PARTS OF A VARIABLE-SPEED HYDRAULIC POWER TRANSMISSION GEAR REMOVED FROM THE CASE

The practical advantages claimed for this hydraulic power-transmission and speed-regulation system, by the manufacturers, are these:

1. The friction losses and wear and tear, incidental to the use of change gearing, are eliminated and there are no shocks on the transmission system, due to poor handling of the same.

2. The necessity for two brakes on the truck is eliminated. The transmission brake, which was almost universal up to three or four years ago, was a heavy, clumsy device that was always in the way, and always giving trouble, and was so unsatisfactory that a large number of manufacturers were forced into the doubtful expedient of replacing it by a second set of brakes on the rear wheels, or by some other equally awkward method. Due to the fact that the speed control is continuous and absolutely positive, at all values between full speed ahead and full speed reverse, there is really no need for any brake at all on the truck, because the braking is accomplished as part of the operation of the gear. Throwing the gear to zero speed, locks the car against travel either ahead or backward, on either an up or a down grade.

3. The necessity for having a clutch in the transmission system, between the driving engine and the change gear, has been eliminated, and with it the continual trouble that attends its use. Scores of different kinds of clutches have been advocated and installed, and all have failed, either by not sticking enough or else by sticking too much. Each variety has been heavy, and clumsy, and a constant source of bother, while operating and in adjusting, and each has been a device peculiarly subject to wear. This gear, because it allows of continuous variation in the speed of the car from zero to full speed, with the engine running constantly at full speed, does away with the need of a clutch.

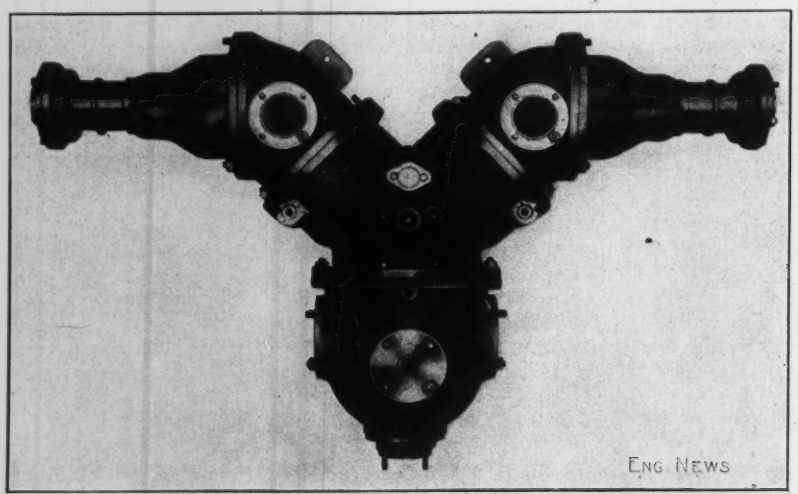


FIG. 5. GEAR-CASE ASSEMBLY OF VARIABLE-SPEED HYDRAULIC POWER TRANSMISSION GEAR

4. The gear effects a saving in tires and drive chains, on slippery streets, and on sharp turns, due to its differential-speed, constant-torque effect above described.

5. Absolute speed regulation is possible for the reasons already given.

6. Positive drive is obtained at all speeds forward and reverse as explained above.

7. Summing up the weights of all the parts it eliminates, including change gears and case, clutch, and transmission brake, with their necessary auxiliary parts, braces, levers, etc., this gear, with its auxiliary parts, is found to weigh considerably less than those devices, whose separate functions it combines in one piece of equipment.

8. Considering the first cost and the rate of depreciation of this gear, in comparison with the combined figures for the usual change gear, clutch and transmission brake, the former is much the cheaper alternative and possesses, as well, a higher degree of reliability.

The gear above described has been installed on motor trucks, in this country and in England, and has been found to work very satisfactorily under actual operating conditions. The pressure on the working fluid varies with the amount of power transmitted, and may reach a value of 1000 lb. per sq.in., under heavy service, but these high pressures can be reduced by increasing the size of the gear, and it is likely that for some classes of service this would be advisable.

In connection with a trial of the gear, mounted on an auto truck chassis, as shown in Fig. 3, witnessed recently in New York City, the following operating features were observed: The gear could be thrown from full speed to zero or from zero to full speed and the car slowed down or speeded up quickly and evenly without jerks and without noise; the car could be stopped, started or reversed at any time by means of the gear irrespective of the speed of the driving engine or of its direction of rotation; on turning corners the speed of the outside driving sprocket was greater than that of the inside sprocket, due to the differential-speed, constant-torque effect above described; and, finally, the jarring, incidental to travel over rough pavements, seemed to have no effect on the gear, and what movement there was, occurred as a unit. In short, the operating characteristics of the gear seemed excellent.

The Cunard Liner "Aquitania," which will share, with the "Imperator," of the Hamburg-American line, the credit of being the largest vessel in the world, is to be launched in March, 1913. In order to allow of her safe passage to the ocean, the navigable channel of the River Clyde will have to be made deeper, and a special dredge for this work is under construction. An interesting feature is the proposed use of Frahn "anti-rolling" tanks to reduce the rolling motion in heavy seas.

Rebuilt Antung-Mukden Ry., China

By J. L. Dobbins*

The Antung-Mukden Railway, built as a narrow-gage military road by the Japanese during their war with Russia, has been transformed into one of the most modern of the oriental railways. It now forms an important link in the Chinese railways and makes possible a reduction of about a day in an around-the-world trip. The masonry structures are particularly worthy of study.

*Professor of Railway Engineering, Imperial Pei Yang University, Tientsin, China.

On Nov. 3, 1911, the formal ceremonies were held in Antung, in Manchuria, which marked the simultaneous completion of the reconstructed Antung-Mukden Ry. and of the Yalu River bridge, crossing the Yalu at Antung. Both of these undertakings had been in the course of construction for the past two years, and have been brought frequently into conspicuous notice among Far Eastern affairs because of the diplomatic questions which have been involved in their construction.

The new line recently completed is a reconstruction to standard gage replacing the light line which was hurriedly located and built by the Japanese as a military measure in 1905-6, during and after the Russo-Japanese war. It joins Mukden, of the province of the same name, and the Viceregal capital of Manchuria, with Antung, which is on the west side of the Yalu River and the principal city on the boundary between Manchuria and Korea. (See map in Fig. 1.) The completion of this line and the bridge which gives it connection to the Imperial Korean Railways, now provides the link that will make possible through traffic from Fusan, at the southern end of Korea, direct to Peking, or to the junction with the Trans-Siberian Ry. at Changchun, and thence to Europe. Through express service between Fusan and Mukden was inaugurated early in 1912, making a 33-hour run between these two points, without change of cars, which is in itself a marked improvement upon inter-road traffic arrangements previously prevailing in the Orient. This new schedule shortens by more than a day the minimum possible time for record seekers in traveling around the world, for in place of the long water trip from Shimonoseki, Japan, to Dalny, in Manchuria, with uncertain connections for the 8-hour trip thence to Mukden, which was formerly the shortest route for travelers coming across Japan *en route* for Europe, it is now possible to reach Mukden from Shimonoseki by crossing the straits to Fusan in the excellent 3000-ton steamers put on for that service, in about 10 hours, and there making direct connections with the through express reaching Mukden in 33 hours.

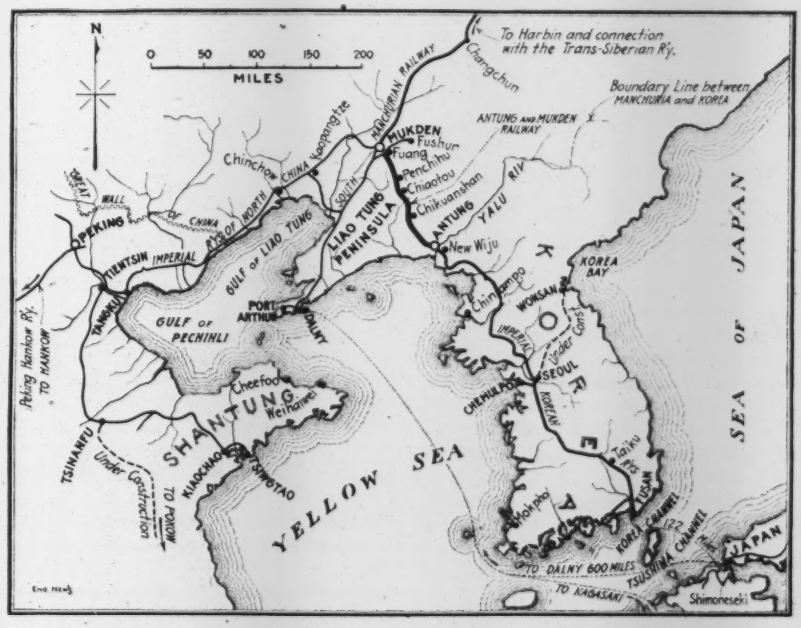


FIG. 1. MAP OF SOUTH MANCHURIA AND KOREA, SHOWING LOCATION OF THE ANTUNG-MUKDEN RY.

HISTORY OF LINE

Because of the international questions involved concerning the respective rights of China and Japan in the construction and control of these two enterprises, a slight resumé of the negotiations proceeding their construction may be of interest.

At the time the construction of the Antung-Mukden light line was started, the Russo-Japanese war was still in full swing; and even after its conclusion, these powers were both still maneuvering with their troops in the recognized Chinese territory of Manchuria, despite the provisions of the Treaty of Portsmouth to the contrary. In view of this continued military occupation, Japan demanded from China the right to complete immediately the partially finished light line, in order to insure direct communication with her base of supplies in Korea, and China was quite powerless to object.

At this time, the main line of the South Manchurian Ry., which had just come into Japanese possession by the terms of the Treaty of Portsmouth, was being thoroughly overhauled and reconstructed between Dalny and Mukden. This work included change of gage from the Russian width to standard, also complete double-tracking and replacing of the former mediocre equipment with substantial rolling stock and equipment, most of which was obtained from America. These changes made traffic very irregular and unreliable over this route, and it was partially to lessen the evil consequences of interruptions of this traffic, and also to supply independent connection with the Japanese base in Korea, that the hurried completion of this line was insisted upon.

Surveys and construction were started almost simultaneously in the the summer of 1905, during the last months of the war. On Dec. 22, 1905, a treaty was signed at Peking, between China and Japan, which settled several disputed points concerning railways and mines in Manchuria, and confirmed Japan's authorization to complete the construction, and to maintain and operate the line for a period of 15 years, after which it was to be sold to China at a price to be determined by an equitable appraisal by engineers of a neutral nationality.

In the spring of 1906, only eight months from the commencement of the work, the half of the line from Mukden to Hsia Ma Tang was ready for operation, and five months later the entire line of 189 miles was completed and thrown open to traffic.

Original Light Line

The road was located primarily with the object of making through connections as rapidly as possible, and every detail was planned to facilitate rapid construction. Very sharp curvature was introduced and heavy grades were used wherever they seemed necessary. Light, wooden trestles were constructed for all stream crossings and tunnels were entirely avoided by long tortuous grades and the occasional use of switchbacks. The gage of the track was 30 in. The limiting maximum grade was 1 in 30, with minimum radius of curvature of two chains, corresponding to a degree of curvature of about 40°. For the track itself, rails of various sections were used as they could be obtained, those near the Mukden end being principally 25 lb. rails of Russian make, which had been captured during the war; while the material for the rest of the line was recruited from American, British and Japanese sources, wherever it was available, the rail sections used varying from 25 to 40 lb. The rolling stock was all new, the final equipment consisting of one hundred 16-ton and fifty 11-ton dinkey engines and several hundred light cars. This was all ordered from America, in time for the first shipments of them to be delivered ready for use by the time the Mukden-Hsia Ma Tang division of the line was ready for them.

This light line, as actually constructed, is an excellent example of location in which every other consideration has been made secondary to the requirements for rapid construction. And its completion for the entire length of 189 miles within 13 months after the first survey was started, sets a new record for rapid work, which is all the more remarkable when the diplomatic and military and financial difficulties that had to be overcome are all considered in addition to the physical obstacles presented by the region through which the line passed.

Travel over such a line was necessarily slow, the schedule time between Mukden and Antung requiring two days, running in the daytime only. And, although a large traffic was rapidly developed, the operation of the railway as a commercial undertaking has always been unprofitable, as the following figures indicate:

The excess of total expenditures over gross earnings since the inauguration of traffic were as follows:

For the fiscal year	1907—1908	Yen* 800,000
	1908—1909	Yen 600,000
	1909—1910	Yen 450,000
	1910—1911	Yen 260,000

That this would be the case was readily foreseen, and immediately upon the completion of the light line, a relocation survey for a permanent standard-gage line was made by engineers of the South Manchurian railway, by whom the existing line was being operated. For this purpose the route was divided into two divisions, and six parties were put into the field, under Messrs. Arai and Tometa as locating engineers. In six months this relocation survey was completed, with the route so chosen that the new construction could proceed without seriously interfering with traffic over the existing line.

*1 Yen = about 50 cents.

Reconstruction

As these preparations for reconstruction progressed, China protested, claiming that the convention made in 1905 did not entitle Japan to widen the line nor to work mines in its vicinity as was being done. Japan thereupon asked for further concessions covering these privileges, which China promptly refused to grant, and, furthermore, called upon Japan to withdraw the troops which had been stationed along the line as police. This Japan in turn declined to do, and as these negotiations which had been begun in the spring of 1907 had reached no conclusion by the summer of 1909, and had apparently made no advance, Japan announced her determination to proceed with the reconstruction without further concessions; and on Aug. 7, 1909, work was started at two points along the line.

This determined action altered China's attitude somewhat, and on Sept. 5, 1909, a convention was signed at Peking which contained a clause permitting this reconstruction, and agreeing to joint operation of the mines in its vicinity by Chinese and Japanese interests. In return, Japan agreed to the policing of the line by Chinese forces, providing it was effectually done, and most of the Japanese troops were subsequently withdrawn to stations along the main line of the South Manchurian Ry.

For this reconstruction, the line was divided into 19 sections, numbering from Antung north, and construction was started almost simultaneously along the entire line, that on sections 19 and 14 having been commenced on Aug. 7, that of sections 18, 17 and 7 on Sept. 5, and in all the remaining sections on Sept. 15.

The line as relocated, joins the South Manchurian system at Fu Ang, a station on the branch line to the Fushun collieries, and about 8 miles from Mukden. From Fu Ang the exact route of the light line was followed to Shih-chiao-tze, a distance of 27 miles; and this section, No. 19, was opened for broad-gage traffic on Nov. 3 of the same year, just three months after the commencement of the work. To do this, temporary trestles were constructed off line at the sites of the seven stream crossings requiring steel bridges, and the permanent construction of these and the widening of the embankments were accomplished later without interruption of traffic. The adjoining sections from Shih-chiao-tze to Pen-chi-hu, 12 miles, were completed on Jan. 15, 1911, while at the other end of the line, sections 1 to 6, from Antung to Chi-kuan-shan, about 50 miles, over entirely new alignment, was opened for traffic on Nov. 3, 1910. The final inauguration of broad-gage service over the entire line took place on Nov. 3, 1911, on the Emperor's

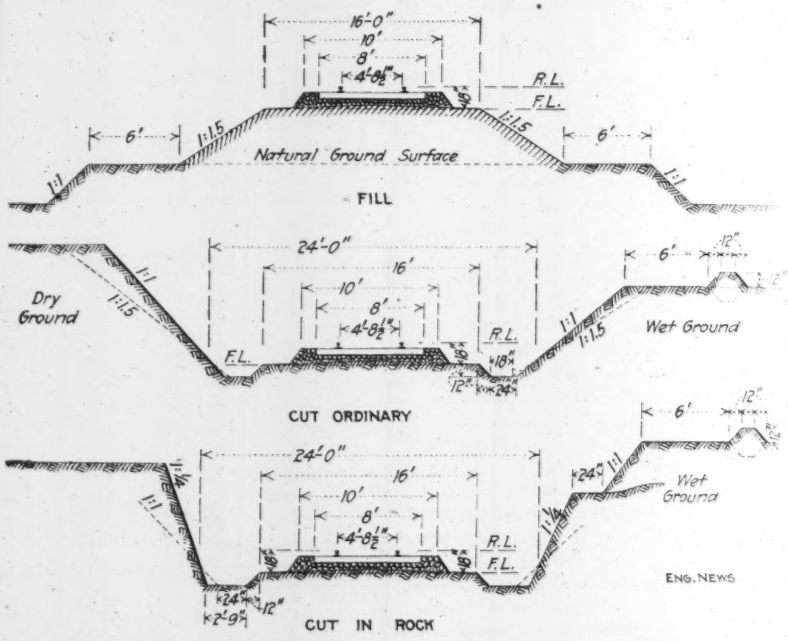


FIG. 2. STANDARD ROADBED CONSTRUCTION ON THE NEW ANTUNG-MUKDEN RY.

birthday, and just a little over two years from the commencement of the work.

The new line from Fu Ang to Antung is 162.57 miles long, a saving in main-line length of 27 miles having been effected over the route of the light line. The maximum gradient is 1 in 80 or 1.125%, without compensation, for both north and southbound traffic, with minimum radius of 15 chains, corresponding to a 5° 45′ degree of curvature. Thirty stations of all classes are established along the line, and yard and siding tracks total 60 miles. The most extensive of these yards is at the Antung terminal of the line, at the junction of the line with the Imperial Korean Railways, and with tidewater in the Yalu River.

The country between Mukden and Antung is very mountainous, with the exception of the first 35 miles from Mukden to Shih-chiao-tze, and three distinct ranges are traversed. On the route are 24 tunnels with a total length of 26,542.36 ft. or 3.09% of the total length of line. The longest of these, through the Fu-chin-ling,* is 4884 ft. long, entirely in limestone. This and the Chi-kuan-shan tunnel (3254 ft.) were driven with power drills, all the others being hand driven. The highest point in the line is reached in the summit of the Fen-shuei-ling tunnel (114 ft.), at an elevation of 1066 ft. above the level of the terminal yards at Antung.

The heaviest work occurs between the Fu-chin-ling range and the summit at Fen-shuei-ling. The road here follows very closely the course of the Hsi Ho, which it crosses 12 times in a distance of 30 miles. Eleven tunnels occur in this same division, aggregating 15,320 ft. or 10% of the entire distance, and for a length of 2600 ft. in the cañon of the Hsi Ho, the track is carried at the foot of the 600-ft. bluffs along the west side of the river, on a 14-ft. roadbed which is built up on a high stone-faced retaining-wall whose footing extends down into the river well below water level. This wall reaches a maximum height above its footings of 45 ft. near the southern end where the road leaves the river and plunges into the Tiao-yu-tai tunnel from which it emerges into more open country.

Tunnels

The conditions under which the Fu-chin-ling tunnel was driven, the section adopted, and the methods employed in driving it, with the exception of the use of power drills, are fairly typical of all the tunnels on the line. The finished net section of the tunnel is horseshoe shaped, of dimensions as shown in Fig. 3. It is lined with squared stone masonry up to a height of 11 ft. above subgrade, surmounted by a three-ring brick arch, both walls and arch being laid in 1:3 cement mortar. Center drainage is provided of uniform section throughout, with net waterway area of 1.5 sq.ft. The ring thicknesses of the arches used and the allowances for drainage varied for different tunnels according to the conditions encountered, but both were constant throughout the Fu-chin-ling tunnel.

Headings, 7 ft. x 7 ft. 6 in., were driven at the top, the subsequent order of excavation being as indicated in Fig. 3. The formation which was penetrated was an unaltered limestone, hard and free from seams, which required no timbering during excavation; and the full section could therefore be completely excavated and cleared before work on the linings was commenced.

Work on the headings was divided into four 6-hour shifts with six men per shift per heading. Electric drills were used, and light was supplied by 16 cp. bulbs strung at 20 ft. intervals throughout the tunnel. Power for these was furnished by a 100-hp. generating plant erected at the east end of the tunnel, consisting of vertical compound engines rated at 375 r.p.m., direct-connected to alternating-current generators delivering current at 3300 volts. This was stepped down in transformers, located in the same building, to 110 volts for use in the tunnel. A complete installation in duplicate was provided for this plant, and there were consequently no delays in the work in the tunnel which were due to lack of power.

The headings of this tunnel were started simultaneously on Aug. 7, 1909, and met in March, 1911, showing an average advance per heading of 4.4 ft. per day, or a little over 1 ft. per shift, and the maximum advance in any heading was 10 ft. in one day.

Shift gangs were made up as follows:

Two drillers, (Japanese) @ 2.00	Y 4.00
Two helpers, (Chinese) @ 0.80	Y 1.60
Two muckers, (Chinese) @ 0.60	Y 1.20
Total per shift	Y 6.80

This gives an average cost for tunnel labor in the headings equivalent to gold $3.05 per ft.

The stone lining, including that of the drain, was contracted at Yen 110 per cubic tsuba,* the railroad furnishing all the cement. The brickwork for the arches was contracted for at Y 29 per tsuba, for the labor only, all materials required being furnished by the railroad. All the stone needed for the linings was obtained from the tunnel dump and cut there to the required dimensions, at the contractor's expense. The brick used were burned at different places along the line of the railroad, where clay particularly suitable for them was found to be available. These cost the railroad from Y 5.50 to Y 6 per thousand, delivered f.o.b. cars.

All the cement used, both in tunnel linings and in bridge work, was of Japanese manufacture and cost Y 5 per bbl., f.o.b. at Antung, Chemulpo or Dalny.

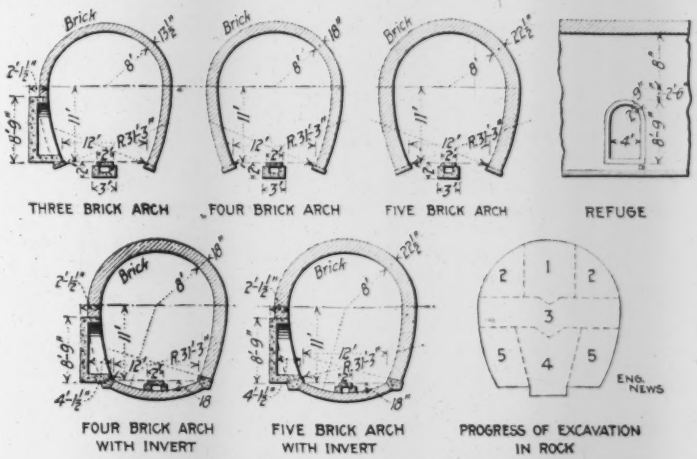


FIG. 3. TUNNEL STANDARDS, ANTUNG-MUKDEN RY.

The total cost of the Fu-chin-ling tunnel was estimated at Yen 730,000, which was about equivalent to Yen 150 per ft. everything complete ready for track laying.

Bridges

The total length of all steel bridges on the line, both truss and plate girder, is 22,610.2 ft. being 2.63% of the entire length of the line. Of these, 55 exceed 150 ft. in length.

The longest of these crosses the Tai-tze-ho just south of the station at Pen-chi-hu. It is 1779.6 ft. in length, overall, made up of 10 deck plate girders, each 60 ft. c. to c. of end bearings, and ten through Pratt trusses, each 105 ft. c. to c. of end pins.

Other data of these trusses are as follows:

Height 25 ft. 0 in. c. to c., total width	20 ft. 6 in.
Truss spacing 17 ft. 6 in. c. to c., camber	11 in.
Loading Coopers E 40, weight of span	69.515 tons (Tons of 2240 lbs.)

*In the frequently recurring Chinese names of rivers and ranges, "ling" signifies peak, "shan" mountain or range, and "ho" river.

*In Japanese measurement the tsuba is a 6x6-ft. square, and the cubic tsuba is a 6-ft. cube, containing 8 cu.yd.

The steel of this particular bridge was purchased from England, from Dorman, Long & Co., but for the entire line the contracts for steel were divided almost equally between American and British sources, with the advantage in price per pound slightly in favor of the American tenders. Detailed designs were submitted by the contractors with their bids for the work and in these the advantage of lightness and consequent lower total cost was slightly on the British side. All trusses on the line were pin-connected at the pedestals only, all other joints being riveted. All the field rivets were hand-driven.

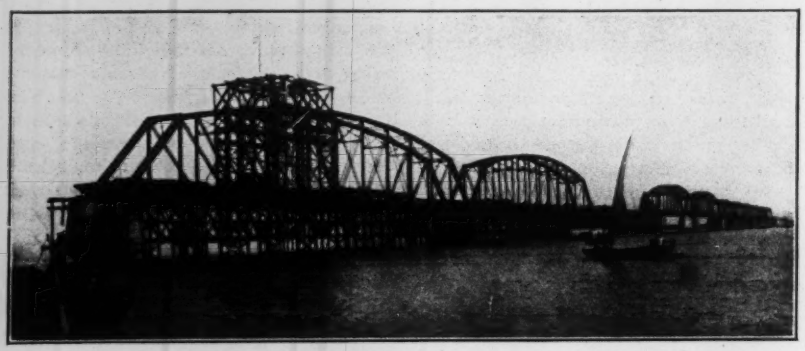


FIG. 4. THE YALU RIVER BRIDGE UNDER CONSTRUCTION

For spans up to 80 ft. c. to c., the following table gives the standard types used and the prices, erected, at which the steel work was figured in the estimates. The actual costs of some of these bridges already erected at the time of the writer's inspection of the line, were reported to agree very closely with these figures, steel work only being considered.

Span	Loading	Wt. in tons 2240 lb.	Price Yen	Type
7 ft.	E 40	1.168	172	I Beam.
10 ft.	E 45	1.975	292	I Beam.
12 ft.	E 45	2.737	404	I Beam.
18 ft.	E 45	4.780	706	L Beam.
20 ft.	E 45	4.775	726	Deck Plate Girder.
30 ft.	E 40	7.751	1,182	Deck Plate Girder.
40 ft.	E 40	14.000	2,170	Deck Plate Girder.
40 ft.	E 45	14.740	2,243	Deck Plate Girder.
50 ft.	E 40	19.491	2,893	Deck Plate Girder.
70 ft.	E 45	36.981	5,628	Deck Plate Girder.
70 ft.	E 40	54.091	8,687	Through Plate Girder
80 ft.	E 45	53.254	8,105	Deck Plate Girder.

Above the length of 60 ft., the selection of the type of structure was determined entirely by the immediate conditions rather than by standard, and the different truss types used were through Pratt, deck Pratt and deck Warren trusses. The maximum length of span used anywhere on the line was 105 ft., the relatively low cost of masonry making longer spans uneconomical. Costs of the 105-ft. spans are given in the accompanying table.

BRIDGE COSTS FOR 105 FT. SPANS

Type	Deck	Deck	Through	Through
Loading	E 40	E 45	E 40	E 45
Span c. to c	105 ft.	105 ft.	105 ft.	105 ft.
Wt. in tons (2240 lbs)	66.902	69.515	66.817	72.271
Price per ton	Y112	Y112	Y112	Y112
Cost price per span	7,493	7,786	7,483	8,094
Erection cost per span	2,207	2,714	2,217	2,206
Total cost per span	Y9,700	Y10,500	Y9,700	Y10,300

Without exception, the masonry of all piers and abutments was carried down to bedrock or to a good gravel footing, to accomplish which coffer-dams and open caissons were used. The costs of foundation masonry necessarily varied considerably according to the conditions under which it was placed. The costs given above for the Tai-tze-ho bridge are not therefore exactly applicable to all the other similar structures of the line, but they are fairly representative of average conditions.

For this bridge, the piers under all trusses are 31 ft. x 8 ft. 6 in., top dimensions, with a 1 in 24 batter on all faces. Under the girders the top dimensions are 17x6 ft., with the same batter, all piers having circular ends. These foundations were all carried down to bedrock with coffer-dams, to an average depth of 15 ft. below water level. The abutments are of the U-type, with the faces of squared masonry, 6 ft. thick, flanked with wing walls of 18-in. rubble masonry backed with gravel concrete.

All squared masonry was contracted for at Yen 100 per tsuba, (gold $6.25 per cu.yd.), the railroad to furnish the cement, but all other costs including excavation and coffer-dams to be borne by the contractor. For rubble masonry and for gravel concrete, payment was made for labor only, on force account, as the cement was furnished by the road and the other materials needed were secured from the river bed near the site of the work.

The numerous stream crossings of the line are all characterized by the excellent masonry work on the piers and abutments, and the thorough protection from wash of all approach embankments by the courses of heavy rock surfacing, usually laid dry (Figs. 5 and 7). And in cases where the waterway crossed was normally dry, but subject to occasional heavy flows on a steep gradient during and immediately after heavy storms, the floor of the stream has been paved with stone slabs between the piers and abutments and for some distance upstream, to prevent any scouring action of the current. Further precautions against wash, which will also add greatly to the scenic features of the line, consisted in sodding the slopes of all high embankments and earth cuts and planting of willow trees at the bases of high embankments.

In the work of reconstruction, 72 temporary trestles for stream crossings were erected, partly for the purpose of opening up the end sections for broad-gage traffic as soon as possible, and in some cases where they were required to prevent interference with the light-line operation. These trestles with their necessary approach embankments required a total expenditure for temporary work of Yen 1,200,000.

EARTHWORK

Unit costs were constant for any contractor's section of the work, the amount depending upon the approximate proportions of rock and earth to be moved. To determine this, a preliminary investigation was made by the engineer of the division and the contractor or his agent, and from the results of this investigation, an average figure was agreed upon for

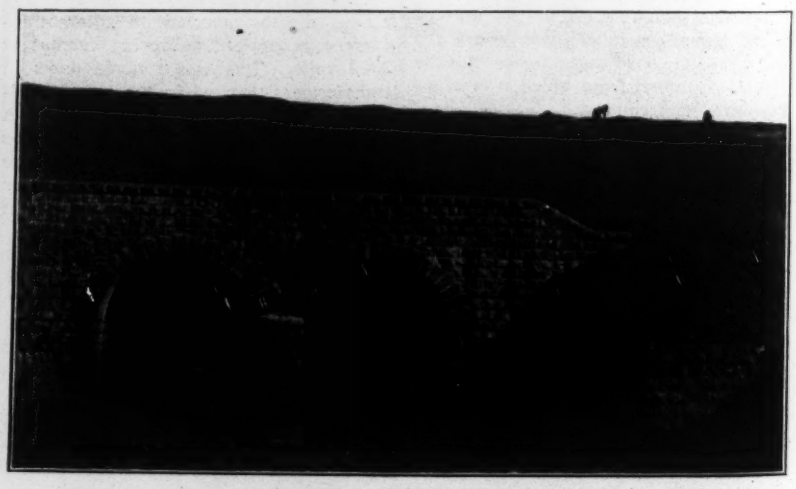


FIG. 5. A TYPICAL MASONRY CULVERT ON THE ANTUNG-MUKDEN RY.

each section separately at which all the excavation within that section was to be done, and the contracts were let accordingly. Excavation costs on this basis ranged from Y 2 to Y 3 per cubic tsuba (gold $0.125 to 0.1875 per yd.) for the entire line, all classes of excavation being included. Probably 30% of this yardage would have been classified as rock work under an American system of contracting.

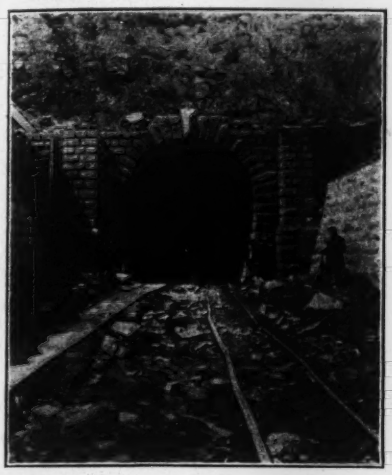


FIG. 6. A TYPICAL TUNNEL PORTAL

[The west portal of the Chin Ling Tunnel]

The contracting for this work was done entirely by Japanese concerns with Japanese superintendence. The average payment for labor employed by the contractors was Y 1 per day for Japanese foremen and 0.40 to 0.50 per day for coolie labor, which was largely Chinese or Korean.

Approximate total costs for the line were given as Y 80,000 per mile for the relatively flat sections, and Y 150,000 per mile for the mountain divisions with their heavier work. The total construction cost of the entire line, including such sidings, station buildings, etc., that had been completed at the time of formally opening the line, but entirely exclusive of rolling stock, was estimated at Y 21,000,000, which is an average of Y 129,000 per mile of main line.

At the eastern terminal of the line, at Antung, adequate transshipping facilities were required to accommodate the large tonnage of freight that comes up the Yalu River in lighters and junks from the deep draught sea-going vessels anchored at the mouth of the river. For these, Antung, on the Manchurian side, and New Wiju, on the Korean side, are the unloading points. To accommodate this freight, the Antung-Mukden line has constructed an eight-track transshipping yard along the river frontage, just above maximum flood level; and a new river wall of cut-stone masonry resting on a pile foundation has been built out at sufficient depth to permit these river craft to moor alongside. The river current is sufficient to keep the channel alongside scoured out to depth, without dredging. The yard area acquired and reserved for this yard and its future extensions is 200,000 square tsuba, about 169 acres, with three-quarters of a mile of river frontage.

As the main line at this end connects with that of the Imperial Korean Railways by means of the Yalu River Bridge (Fig. 4), the grade elevation of the main line and of the station yards is considerably higher than that of the river yards, this height being determined by that of the bridge, for which grade elevation is 21 ft. above maximum high water, and consequently the same height above the elevation of the river yards. This main-line approach to the bridge is carried on a wide embankment, which provides also the highway approaches to the bridge, all of which cross three wide subways which have been left to give easy access with teams and carts to the yards along the river, just to the southwest of the main line.

The station and the station yards, also of eight tracks, are located on higher ground, nearer the center of Antung city, and about a mile from the bridge and the transshipping yards. This station will be the nominal junction point between the Antung-Mukden Railway and the Imperial Korean Railways as it is the station nearest the actual junction point of these two systems. The Manchurian-Korean boundary line passes through the center of the navigable channel of the Yalu River, but by special international agreement, the Yalu River Bridge was built and is to be maintained entirely by the Imperial Korean Railways, so the rights-of-way of the two railways meet at the east abutment of that bridge.

The Antung-Mukden line, as completed, affords a very good illustration of the meeting place of American and European standards of railroad practice, modified to suit the local conditions by the engineers in charge of the work, who fully appreciate their peculiar opportunity to select what they wished from the markets and methods of the world.

In the surveys, the English system of defining curvature by radius and grade by a proportion were followed, the advantages of which methods seem to an American engineer to be at least doubtful.. In bridge design the use of riveted rather than pin-connected trusses was adopted for all structures, in accordance with European tendencies, thus securing the advantage of additional rigidity and a slight saving in weight over similar trusses pin-connected, while the maximum length of span was not sufficient to make trusses of this type objectionable because of possible large indeterminate stresses.

American locomotives will be largely used on this line, with passenger coaches and freight cars built in Japan after American models, and therefore all bridge loadings were figured according to Cooper's specifications.

The cheapness of labor and the plentiful supply of materials for masonry permitted the uniformly excellent finishing of tunnel work with substantial masonry linings without prohibitive cost, and the proportioning of pier heights and lengths of span on the basis of costs, has resulted in shorter spans and more frequent piers than would have been economically possible under the same topographic conditions on either European or American roads.

FIG. 7. STONE ABUTMENTS FOR AN OVERHEAD CROSSING IN THE ANTUNG YARDS, ANTUNG-MUKDEN RY.

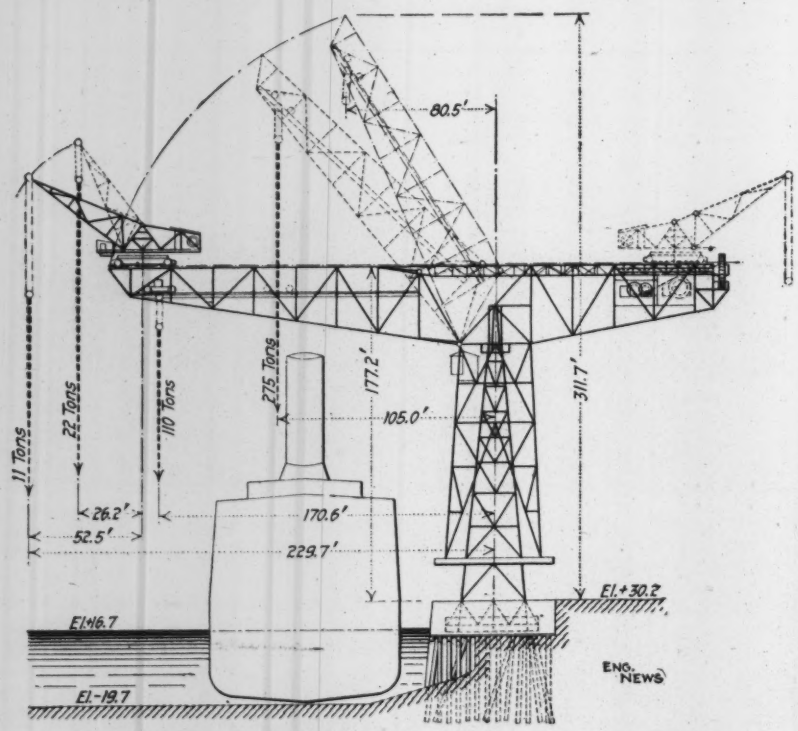
For much of the above data, the writer desires to acknowledge his indebtedness to the courtesy of S. Hori, Chief Engineer of the South Manchurian Ry., under whose direction this reconstruction was completed, and also to Messrs. K. Iida and A. Ichie, Division Engineers in charge of construction.

A Large German Cantilever Crane

The largest cantilever crane which has come to our notice has been recently completed in the workshops of Blohm & Voss, shipbuilders, of Hamburg, Germany, for use in their shop. A description of the crane, with a drawing from which the accompanying figure has been taken, appeared in *Le Genie Civil*, Sept. 28, 1912, and from that article we have abstracted the following description:

The crane is installed on the quay immediately alongside of the waterfront. It comprises, as shown in the cut, a central tower carrying a cantilever beam, the river end of which is pinned at the central pier so that it may be raised as shown by the dotted lines in the drawing. Additional movement is achieved by a smaller 10-ton crane which moves on the main bridge, by the small hoist which moves on the lower deck of the main bridge and by both longitudinal and rotary movements of the whole structure along the quay front. This crane can carry 11 tons hung from the smaller crane at a maximum distance of 229.7 ft. from its center, or a maximum of 275 tons from the end of the main bridge, a distance of 105 ft. from the center of the pier.

In several past issues of ENGINEERING NEWS, notably that of Aug. 17, 1911, p. 215, we have noted some very large cantilever cranes. The largest hitherto described was that erected at the Hamburg shipyards of the Stettiner Vulcan in Germany. This crane carried 220 tons at a radius of 104 ft., or 110 tons at a radius of 169 ft. This crane was tested for a load of 275 tons at a radius of 104 ft., which gives a foot-ton capacity of 28,600, but the crane shown in the accompanying view is much larger inasmuch as it has a working load of 28,875 foot-tons with a test capacity much larger.



250-TON CANTILEVER CRANE FOR BLOHM & VOSS, HAMBURG

Gas Pressure Regulations of the Public Service Commission for Companies in the Borough of Manhattan, New York City

On account of the large number of complaints received by the Public Service Commission for the First District of the State of New York in regard to poor gas, inadequate and fluctuating pressure, excessive bills, etc., in New York City, it was decided to conduct an investigation into gas-pressure conditions to determine what regulations were needed to insure to consumers an adequate and reasonable pressure at all times. As the Borough of Manhattan held the greatest variety of service conditions, the largest number of consumers, and the maximum congestion of population, it was decided to begin there. W. A. Baehr, a consulting gas engineer of Chicago, was employed to direct a survey.*

THE COMMISSION'S ORDER

As a result of these studies, the Commission has issued an order directing (1) that the gas companies in this borough shall provide and maintain recording pressure gages of approved type so located that no gas consumer will be more than 3800 ft. in an air line from the nearest gage on the distribution system by which he is supplied, and so located that there will be at least one gage per square mile of territory supplied. Each gage is to be located as near as possible to the point of minimum pressure for each district, and a separate pipe is to be run from main to gage. (2) On and after July 1, 1913, the minimum pressure measured at the consumer's end of the company's service pipe must not be less than 2 in. (water column) on two consecutive days. (3) After July 1, 1913, the maximum gas pressure, measured as before, must not exceed 6 in. on two consecutive days unless the consumers supplied from such a service pipe have made a specific request for excess pressure. (4) After July 1, 1913, the maximum daily pressure variations (independent of momentary and pulsating variations) are not to exceed 3 in. on two consecutive days. After July 1, 1914, this daily pressure variation is not to exceed 2½ in., and after July, 1915, the figure is fixed at 2 in. (5) After Jan. 1, 1913, the maximum momentary pressure variation (sudden and practically instantaneous increase or decrease of pressure, not recurring with regular periodicity, frequency, or amplitude) must not exceed a total range of 0.8 in. water column on two consecutive days. (6) After July 1, 1913, the maximum pulsating pressure variation (sudden increase or decrease of short duration recurring with regular periodicity or frequency, and usually with the same amplitude) must not exceed a total range of 0.8 in. on two consecutive days. After Jan. 1, 1914, this variation is not to exceed 0.5 in. on two consecutive days.

THE PRESSURE SURVEY

GAS MANUFACTURE AND DISTRIBUTION—The report of the consulting engineer shows that the gas is manufactured and distributed by four concerns: the Consolidated Gas, the Standard Gas Light, the New Amsterdam Gas, and the New York Mutual Gas Light Companies. The Consolidated company is a combination of six earlier concerns, and the New Amsterdam company is a consolidation of three. All four companies are related through stock ownership, etc.

The present scheme of distribution

*See report "Investigation and Report upon Gas Pressure Conditions," by W. A. Baehr; published by the Public Service Commission, First District, State of New York, 154 Nassau St., New York City.

system covering the entire borough and a belt line for slightly higher pressures used to supply the various holder stations.

The low-pressure system receives gas from holder and manufacturing stations in two ways: (1) directly through station governors and valves which are regulated to maintain a proper pressure in the immediate district; (2) through feeder mains radiating from the stations and connecting to the supply mains at points remote from the station. These feeders are supplied with gas through governor- or hand-regulated valves.

The pressure control is a combination of (1) control through regulation of the station-outlet valve according to a predetermined schedule and (2) a semi-automatic regulation of the feeder-inlet valves in accordance with pressure signals from distant points in a supply district (the "telemetric" system).

For supplying holder and storage stations with gas from the manufacturing stations and for transferring gas between holder stations, all stations of the four gas companies are inter-connected by pumping mains which form a loop system, embracing the territory north of 19th St. and south of Manhattan St. and 115th St.

The old New Amsterdam company had virtually two separate systems, and the pressure control of these two systems is still more or less independent. By analyzing test charts and studying the pressures at each control station, it was found that the stations which formerly belonged to six component companies of the present Consolidated company still control the pressure in their original districts; but there have been numerous inter-connections so that it is impossible to define the exact boundaries of each. Some charts show the prominent characteristics of several stations, and a few charts show characteristics of the control of several companies, indicating inter-connections between the main systems of the various companies.

The Consolidated company operates gas-manufacturing stations on the Island of Manhattan at (1) 14th St. and East River (coal gas), (2) 42d St. and North River (coal gas), (3) 21st St. and Avenue A (water gas), (4) 44th St. and North River (water gas), (5) 99th St. and First Ave. (water gas). In addition, gas is received from the Long Island plants through mains laid in a tunnel under the East River to 71st St.

The Standard company operates a water-gas plant at 115th St. and East River in addition to receiving gas through the 71st St. tunnel from Long Island. The New Amsterdam company operates no manufacturing stations in Manhattan, but receives all of its gas through the Long Island tunnel. The New York Mutual Gas company operates a water-gas plant at 12th St. and East River. The various gases are thoroughly mixed in the pumping lines and holders before delivery to consumers.

METHOD OF STUDYING GAS-PRESSURE CONDITIONS—The gas companies have, in all, 87 recording gages distributed throughout the borough. Charts are placed on these gages daily and are delivered to the office of the superintendent of mains, where they are inspected and filed. The gages are distributed more or less uniformly and serve to keep proper officials advised as to pressure conditions. The privilege of inspecting and copying these charts was freely granted by the gas companies, and free access to all maps and records was given. These gages were not used for the consulting engineer's studies directly since they were in most cases attached to active service pipes, so that they did not indicate at all times the true pressure existing in the main, this being reduced by the drop in pressure due to gas flow past the gage connection.

It was desirable to take the pressures simultaneously throughout the borough at close intervals but, as this would have required some 200 gages and an extensive organization, the scheme was prohibited.

As an alternate method, six portable recording gages were purchased and the gas companies furnished a pipe fitter and a light single-horse wagon and driver. The location of points, at which pressure data were desired, were then determined from a map of the borough on which were shown the location of each of the company's gages.

Street-lamp posts were selected nearest the desired location and on these a wooden box was mounted with lock and clamps for protection against theft. The recording gage was then set and leveled up in this box. A small plug, below the shut-off key of the Welsbach lamp, was removed, a nipple inserted therein, and a hose connection led down through the box to the gage. Previous to attaching the hose, the gas pressure was taken with a U-gage and checked against the reading of the recording instrument. In order that the particular gage at each location might be known, the number was written on each of its charts, and in cases of apparent error it was possible to verify the accuracy of the gage. No trouble was experienced from tampering with the gages, and only in a few instances were the hose connections disturbed. Six gages were located each day on Monday, Tuesday, Wednesday, Thursday and Friday of each week. The period covered by each chart varied from 22 to 23 hr. a day, a short time being required to shift the gage to a new location.

A series of pressure tests were also taken in typical apartment, tenement and factory buildings to determine the condition of house piping, etc. In these tests a gage was placed at the point where the service enters the building and other gages on convenient gas outlets for each floor. In some cases the nearest street-lamp post was found to be connected to the same main as the building service, and a gage was placed thereon to record the pressure within the main.

EFFECT OF ELEVATION—To obtain charts to show the increase in pressure caused by elevation, gages were placed in the Singer Bldg., on lower Broadway. This is 46 stories high and has a 3-in. service pipe with one riser running to the 39th floor. There is an outlet for one hall light on each floor, but the only gas used in the building is to supply a gas range, on the 39th floor. Gages were placed in the basement, at the inlet and outlet of the meter, and one was also attached to the hall outlet on the 39th floor. The difference in elevation of these gages was approximately 545 ft. The rise in pressure shown was practically 0.5 in. per 100 ft. of elevation.

PEAK LOAD PRESSURES—A study of the station pressures necessary to maintain service showed that Dec. 20, 1910, was one of the heaviest loads during the winter 1910-11. As the charts taken by the Commission dated after the period of maximum load had passed, it became necessary to determine what pressure conditions existed at the various locations during the season of heaviest load. To arrive at this, copies of the charts from all the companies' gages in the immediate neighborhood of the Commission's test points were made. Copies of the corresponding chart from the companies' gages for Dec. 20 and 21 were also obtained. The pressures on Dec. 20 at the Commission's test points were assumed to correspond to the differences between the maximum and minimum of the two charts of the companies.

STATION CONTROL—One reason for obtaining the charts at the regulating stations was also to determine what stations are responsible for pressures in each district. This was determined by a comparison of charts of the Commission and the companies and noting the similar characteristics. In nearly all cases the controlling station was easily determined, but in some cases it was found that the charts exhibited peculiarities of several stations. In some cases the similarity was apparent only during light periods of load, so that stations were accepted as controlling which imposed certain characteristics throughout the entire period.

PRESSURE CONDITIONS IN MANHATTAN

Inspection of corrected maximum pressures disclosed remarkable uniformity, the result averaging very nearly 3 in. all over the island. A few as high as 4 in., and five above 4 in. were found. On these findings Mr. Baehr reported that excessive pressure on consumer's premises did not exist. He held that the instances where even 4 in. was found were

so few that apparently the companies could carry higher maximum pressures without causing poor service.

A tabulation of the corrected minimum pressures did not show as favorable a condition of affairs. At 82 stations minimum values were found ranging between 0.85 and 2 in.

Six instances were shown where the daily variation of pressure exceeded 2 in., and there were a considerable number where the variation was between 1.5 and 2 in. The tests showed many locations subject to momentary variations and pulsations. In some instances the range of fluctuations and the number of hours per day during which they persisted were very great and beyond reason. The cause which usually produced the largest fluctuation was the operators' opening or closing governing valves too far.

An inspection of the corrected maxima of the charts showed that the same locations which had large maximum pressures had this during the time of heavy load, and that a large percentage of them occurred in zones close to the holders.

Except in a few cases, most of the minimum pressures occurred at the time of heavy load. Tables appended to the report showed the maximum and minimum pressure of the various test points together with the maximum and minimum pressures at the controlling station.

Reasonable Service

Mr. Baehr's report discusses the degree of reasonably good service it is commercially practical to render with satisfaction to the consumer, it being apparent that absolutely uniform pressure is not feasible.

In the early days of the gas industry, gas was distributed through pipes not to exceed the maximum pressure of the works holders, and this rarely rose above 3 or 4, or possibly 5 in. In the course of time, gas came into more extended use, and for purposes otther than lighting. After the application of the principle of the Bunsen burner, higher pressures were gradually adopted, with increased economy for the average consumer. The average pressure at which gas is supplied to the average consumer today is nearly 3 or 4 in. and in some cases as high as 5 or 6 in. of water column. Where the low-pressure system is in use, as in New York City, the pressure received by any consumer and the variation of pressure is largely due to conditions in the gas mains and service pipes. Hence, it is highly important that certain limits of pressure be observed to prevent the customers being subjected to uneconomical conditions.

House piping is rarely adequate for the service required. The friction of gas passing through is comparatively great, so that whenever a burner is turned on there is a drop of pressure. In old buildings, the piping is usually entirely inadequate, since it may have been installed to serve only a few fixtures, or it may have become clogged.

While increase of load, causing drop of pressure at a given point, can be compensated for by increase of pressure at district regulators yet, in a low-pressure system, it is obvious that it is extremely difficult to maintain unvarying pressure at a given point under such conditions. In Manhattan, owing to the large extent of congested territory, the load comes on at different times of the day in different parts of the city, so that the gas companies by distributing from numerous points were held to be able to compensate for marked variations in pressure due to changes in load.

Pressure Zones—In a large city, it was believed to be reasonable to consider the territory served by each district regulator or supply station as divided into three zones. The first would include those portions of district in immediate proximity to the holder or governor station from which gas was delivered into the distribution system. It was held advisable to permit a company to carry a larger range of pressure in the areas which make up the first zone than permitted in outlying ones, since it would involve a large capital investment to make the services as good as in other zones.

The second zone would include the thickly built up portions of the district supplied by each regulator or distributing point; this would cover the larger percentage of the consumers and the pressure should be so regulated that the service in the second zone would be as nearly uniform as possible within reasonable limits.

The third zone would cover the outlying districts—those portions in the extreme outskirts or at lower levels. It was stated to be entirely practical to issue regulations taking account of such zonal effects.

Variations of Pressure—Where large areas and many consumers are affected by excessive momentary variations caused by faulty hand operation of governing valves, it was deemed reasonable to limit not only the range but also the frequency of such variation.

Pulsating effects were found to be caused usually by gas engines on the line; for instance, a single-cylinder, double-acting four-cycle engine, running at 300 r.p.m. causes, in the supply line, five pressure-variation cycles per second.

On very windy days the effect on a gas holder is to cause fluctuations which are transmitted through the low-pressure distribution system. It was noted that where pulsations were general for any particular day or hour and could be traced to winds or storms, the advisability of exacting a penalty from the gas company needed to be carefully considered.

Yearly Test—The amount of gas consumption varies materially at different seasons but, the report holds, whatever the time of year of maximum consumption per day and whatever hour during the day constitutes the peak load, it is requisite for a company to take a complete test of gas pressure over the entire territory served by it during that period. During this yearly test, it is well to trace the pressure troubles through the trunk mains, but it is equally important to determine pressures in the smaller mains which constitute the larger network.

It was stated to be requisite for a company to install pressure-recording gages, preferably one for each square mile of its territory, although in some cases more might be necessary. These should be installed on special service pipes not supplying anything else.

The Consumer's Side—Ordinary gas appliances are designed to operate efficiently somewhere between 1½ and 6 in. of water column, and means of adjustment are usually provided so that the burner may consume gas efficiently at the pressure at which the gas is being delivered. Adjustments for best results at one pressure will not give good results at either higher or lower, but within a given range of pressure an adjustment for an intermediate point will result in satisfactory service. A consumer has a right to expect, says Mr. Baehr, that the pressure at his meter shall never be less than a certain amount and that the momentary and pulsating pressures, as well as the maximum daily variations, should not exceed certain limits.

If one consumer has his appliances set to operate most efficiently at 3 in. pressure and another has his set for 6 in., they would both have entirely satisfactory service and the bills would not be affected by the fact that one had higher pressure than the other, except for a tendency toward greater efficiency of appliances at the higher pressure.

The Company Side—It was felt fair and right to hold a gas company generally responsible for pressure conditions at a consumer's meter. It was noted that, in certain large buildings, a portion of the service pipe may be installed by the owner—leading from the point where the gas company's service enters the building to distant meter closets. To some extent, gas companies may have control over the size of such service pipes, and if a company is to be held responsible for pressure conditions at the meter they should be given a reasonable amount of control over the size of such pipes. In justice to the company, however, it was held that the gas consumption might vary greatly owing to the sudden growth of a given district and the increase in load

may become so great that the ability of the company to supply a given minimum pressure might be exceeded. The question was brought up whether it is fair to penalize for not supplying sufficient pressure in such a case, and as to how much time should be allowed in which to reinforce the pressure of that territory. Such defects are not usually discovered until the winter season sets in, when the high cost of laying mains is to be considered.

Letters to the Editor

Concrete Floor Collapse, Kansas City, Mo.

Sir—The failure of the floor system of the Alameda Hotel, on Sept. 26, in Kansas City, Mo., will probably be widely heralded as a failure of reinforced concrete by our burned-clay and tile friends. Having personally investigated the structure shortly after the collapse, the writer would like to forestall a few of them.

The concrete seems to have been first class. The bearing of the concrete, however, on the brick wall, across the entire end of the building, appears to have been about the width of one brick. Four stories of the wall, which appear in the accompanying halftone, were about 12 in. in thickness. The outside facing brick were, as mildly stated in the coroner's report, insufficiently bonded to the backing, which consisted of 8 in. of brick laid up in lime mortar, each floor bearing in turn on the inside 4 in. of this mongrel type of wall.

The question that naturally arises is whether the failure was primarily a failure of brick work or a failure of concrete. Suitable bearing of beams or slabs on walls is frequently considered totally unnecessary by some who put up concrete work. The writer has on one or two occasions inspected work where the workmen were apparently trying to cast the beam against the vertical face of a brick wall with the idea that it would support its load perfectly by its adhesion to the vertical face rather than through a reasonable and efficient bearing, and in order to provide room for the steel which was intended to project the wall 2 ft. or more, they very carefully bent it back into the beam box.

C. A. P. Turner.

Phoenix Bldg., Minneapolis, Minn.,
Oct. 21, 1912.

[The failure noted in the letter above resulted in the death of four workmen and the injury of some others. The building, in course of construction, had brick bearing walls, concrete interior columns and tile-and-concrete floors and roof resting on the walls and columns. Failure occurred by the primary collapse of the roof upon the removal of its falsework shores. Details of the construction and of the failure have not yet been made available, but the following verdict of the coroner's jury, rendered on Oct. 10, as a result of an inquest, throws some light on the causes of the collapse. Incidentally the verdict is remarkably dissimilar to the usual coroner's jury report, as it bears evidence that the jury made an intelligent study of the disaster. The verdict follows:—Ed.]

The Interior of the Collapsed Alameda Hotel, Kansas City, Mo.

We find that the cause of the collapse of the said Alameda Hotel Building was due to the following successive causes:

That the owner of the said Alameda Hotel Building, Walter M. Davis, used an improper method of obtaining the reinforced-concrete design, to wit, by letting the contractor for the reinforced concrete and the material men furnish this design, thereby making it an inducement to the contractor and those who had the subcontracts under him, to make a design embodying a less amount of material than is specified by the building code.

That the design for the reinforced concrete, made by the Trussed Concrete Steel Co., Detroit, Mich., is weak and in many respects not in accordance with the building code.

That the architect of the building, Clifford B. Sloan, to whom this reinforced-concrete design was submitted, passed it on to the contractor without checking up the design.

That the superintendent of buildings, F. B. Hamilton, issued the permit for this building without checking up the plans and ascertaining that the reinforced-concrete design was weak and not in accordance with the building code.

That the building was not properly inspected during its course of erection by the department of buildings, due to the lack of a sufficient number of competent inspectors in this department.

That the owner in undertaking to superintend the erection of the building himself, assumed the responsibility for the actions of the workmen and contractors on the building, and that it was his duty to see that the forms were left under the concrete for a proper length of time, and that the plans and specifications were carried out, which he did not do.

That George H. Seidhoff, the contractor for the reinforced concrete, placed a weight of cinders on the roof and pulled the forms in the presence of the owner, while the concrete was still weak and not capable of supporting its own weight and the superimposed load and this without having made a sufficient examination of the concrete to ascertain its strength, and that the roof slab failed under the superimposed load and carried the other floors and portions of the wall down.

And we are further of the opinion that if the design for the reinforced concrete had been made in accordance with the code, that the roof slab probably would have stood up after the forms were removed; that the use of lime mortar in the brick walls and insufficient bonding probably did augment the disaster.

FIELD AND OFFICE

New Rules for Resuscitation

New rules for resuscitation of victims of electric shock have recently been recommended by a commission representing the American Medical Association, the National Electric Light Association, and the American Institute of Electrical Engineers. The "prone" or Schäfer method is included, being superior to the old and well known Sylvester movements because of greater simplicity and ease of use.

While this commission has formulated these rules especially for cases of electric shock, yet they apply to resuscitation

Fig. 1. Inspiration; Pressure Off

Fig. 2. Expiration; Pressure On

FIGS. 1 AND 2. THE "PRONE" OR SCHÄFER METHOD OF RESUSCITATION

work in general. The instructions, reprinted below, have been copyrighted by the National Electric Light Association, but permission to reprint is freely given on application.

FOLLOW THESE INSTRUCTIONS EVEN IF VICTIM APPEARS DEAD

I. IMMEDIATELY BREAK THE CIRCUIT

With a single quick motion, free the victim from the current. Use any *dry nonconductor* (clothing, rope, board) to move either the victim or the wire. Beware of using metal or any moist material. While freeing the victim from the live conductor have every effort also made to shut off the current quickly.

II. INSTANTLY ATTEND TO THE VICTIM'S BREATHING

(1) As soon as the victim is clear of the conductor, rapidly feel with your finger in his mouth and throat and remove any foreign body (tobacco, false teeth, etc.). Then *begin artificial respiration at once*. Do not stop to loosen the victim's clothing now; *every moment of delay is serious*. Proceed as follows:

(a) Lay the subject on his belly, with arms extended as straight forward as possible and with face to one side, so that nose and mouth are free for breathing (see Fig. 1). Let an assistant draw forward the subject's tongue.

(b) Kneel, straddling the subject's thighs and facing his head; rest the palms of your hands on the loins (on the muscles of the small of the back), with fingers spread over the lowest ribs, as in Fig. 1.

(c) With arms held straight, swing forward slowly so that the weight of your body is gradually, but *not violently*, brought to bear upon the subject (see Fig. 2). This act should take from two to three seconds.

(d) Then immediately swing backward so as to remove the pressure, thus returning to the position shown in Fig. 1

(e) Repeat deliberately twelve to fifteen times a minute the swinging forward and back—a complete respiration in four or five seconds.

(f) As soon as this artificial respiration has been started, and while it is being continued, an assistant should loosen any tight clothing about the subject's neck, chest, or waist.

(2) Continue the artificial respiration (if necessary, two hours or longer), *without interruption*, until natural breathing is restored, or until a physician arrives. If natural breathing stops after being restored, use artificial respiration again.

(3) *Do not give any liquid by mouth until the subject is fully conscious.*

(4) Give the subject fresh air, but keep him warm.

III. SEND FOR NEAREST DOCTOR AS SOON AS ACCIDENT IS DISCOVERED.

Pipe Laying with a New Pipe Wrench

In laying 4-in. and 8-in. mains of threaded pipe the Western Gas & Electric Co., of Aurora, Ill., has been using a new style of pipe wrench with very satisfactory results. The wrench, Fig. 1, consists of a flexible clamp composed of three sections hinged together and attached to the end of a heavy bar, the end section being hooked to this bar when fitted to a pipe. The clamp grips the pipe tightly but uniformly and without crushing, and is so made that it cannot slip or loose its grip, being held in position by a lock bolt in the head of the handle. It may be said that the wrench has for some time been made in small sizes for ordinary pipe work, having the advantage of convenience for use on pipes difficult of access. It is now being made in sizes up to 8 in., and can be made in larger sizes as ordered. One of its advantages is its comparatively light weight, this being only 65 lb. for the 8-in. pipe, so that it can be handled readily by one man.

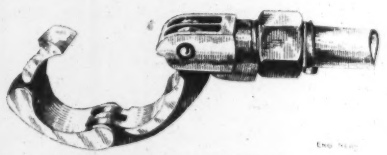


FIG. 1. FLEXIBLE PIPE WRENCH USED ON 4-IN. AND 8-IN. PIPE

In Fig. 2 is shown the wrench fitted to the 8-in. gas main. A pipe handle is fitted to the bar, to extend above the top of the trench, so that a rope may be attached by which several men can operate it. The wrench was used by L. H. Johnson, Master Mechanic and Superintendent of Gas Plants of the gas company, in laying a 4-in. main from Aurora to Oswego and an 8-in. main from Joliet to Kyle (18 miles). The foreman on the former line reported that the work was done better and quicker than by chain wrenches, and that leakage (due to the pipes not being screwed up tight enough) was considerably lessened. The reason given for this was that with the ordinary wrenches the pipes could not be screwed thoroughly tight without danger of crimping or splitting the pipe. In addition, the

FIG. 2. PIPE WRENCH IN PLACE ON AN 8-IN. GAS MAIN (THREADED PIPE)

new device was much more easily handled. On the Joliet line, the foreman laid 105 lengths of 8-in. pipe (about 2100 ft.) in 9 hr. 10 min., while ordinarily a day's work would be about 1000 ft. This is considered to be a record in such work

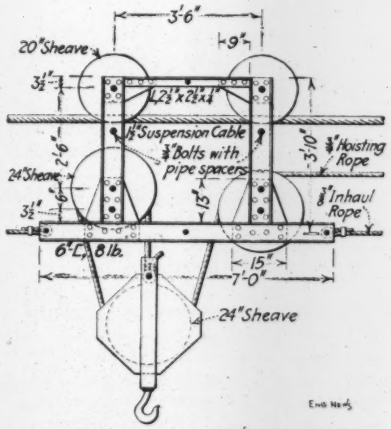
There was not a split or crushed pipe on either line, and another important feature was that the wrench did not damage the pitch coating of the pipes.

The wrench described is made by the Parmalee Wrench Co., of Chicago, and the high-pressure long-distance gas system referred to was described in our issue of Apr. 12, 1906.

A Stiff Cableway Carriage

A cableway carriage made of stiff shapes instead of flat bars, used at Thetford Mines, Que., in asbestos mining work, is shown by the drawing herewith. Ten such carriages have been in service for more than two years, with satisfactory results. E. Torrey, Sherbrooke, Que., who designed the carriage, describes it as follows:

The carriage is built of structural shapes instead of the usual flat bars, giving it the advantage in strength, lightness, cheapness and ease of assembling. The sheaves are the same as commonly used, with hubs 4 in. long and 2½ in. bore. A steel sleeve 2 in. in diameter



CABLEWAY CARRIAGE BUILT UP OF STIFF SHAPES—E. TORREY

and 4⅛ in. long, bored for a 1-in. bolt, forms the sheave pin, and acts as a separator for the halves of the frame. A brass bushing 4 in. long is bored and turned to run free on the pin and in the hub, and is drilled with ⅜-in. radial holes to carry the lubricant. Beside the sheave pins, pieces of pipe over ¾-in. bolts are used as separators.

There is nothing unusual about the fall block, unless it be the side straps, which are bent to guide the block when it strikes the bottom chord of the carriage. Here the 6-in. channels give a stiff resistance, and so far have shown no sign of bending, whereas the usual flat bars last but a few months.

ENGINEERING NEWS, Sept. 14, 1910, p. 316, shows the usual type of construction, except that angle iron is there used to form the bottom chord.

Forest Roads and Trails*

During the past few years the U. S. Forest Service has done a great deal of work in the development of the forests of the West, part of which consisted in building roads and trails. At present, trails are of much more importance than roads, because they are much cheaper and can be built in more inaccessible country. The great need of the forests at present is adequate fire protection, for which the trail will suffice, as far as the traveling over the country is concerned. In 1910 an appropriation of $600,000 was made for improvements, of which a considerable sum was used for roads and trails, as 2225 miles of trails and 320 miles of roads were built. In 1911 this appropriation was cut down to $275,000. Plans now prepared call for the building of over 30,000 miles of trail and 7000 miles of road at an estimated cost of $3,000,000. Several of the states have plans for road and trail construction, notably Wisconsin, Minnesota and a few of the Eastern states. In the majority of states, however, forestry work does not include road and trail building.

FOREST TRAILS

The main object in building trails is to give accessibility through the forests. Other purposes are to provide: 1, routes of travel for administrative purposes; 2, routes for packing (to mining camps, etc.); 3, pleasure or scenic trails; 4, stock trails; 5, fire lines. Trails are not of great value for fire lines, however, owing to their narrowness.

Trails may be classified as main, secondary and spur. Main trails are those connecting ranger districts. They should be well worked, well cleared of brush and well blazed; they should have a fairly wide tread, with a maximum grade of 10 to 12%. Secondary trails are those connecting the main trails. They should be fairly well worked and blazed, and have a maximum grade of 12 to 15%. Spur trails are usually short, connecting lookouts with the more important trails, and are used only by the fire guards. They can be blind trails and need only be brushed out enough so that a horse can get through with ease, which would mean a cleared space of 4 or 5 ft. A grade of 15 to 20% would be permissible.

The first and most important consideration in trail construction is always the location, and grade is the determining factor in location. Where it is steep, switchbacks should be resorted to. The methods used in location are: 1, compass and Abney hand level (accurate); 2, hand level only (fairly accurate), and 3, ocular leveling (inaccurate). A route should first be reconnoitered and definitely decided upon before it is staked out. The main points can be sketched in on a map by means of a compass and hand level. On short distances the hand level will be sufficient. Laying out by eye is a poor method and inaccurate at its best. The route should be staked every 50 to 100 ft. and blazed, but as a usual thing routes are laid out by blazing only. The blazes should be made close together along the trail so that there will never be any trouble in following them. Location should always be from the top of a hill to the bottom, otherwise the maximum grade is apt to be exceeded, because in locating from the bottom there is danger of making the grade steeper than necessary. Location work can be done very well with a crew of three men and costs from $2 to $10 per mile.

There are several choices for trail routes: 1, valley or cañon; 2, ridge route; 3, trails crossing mountains, and 4, foothill. The use of one of the first two routes depends somewhat on the nature of the country. Where the cañons are extremely steep, narrow, and full of boxes or interrupted by cliffs, the ridges and sidehills can be followed without much trouble. For the latter, the south sidehills should be used, because they are passable three weeks earlier in spring and later in autumn than north hillsides. Where the country has been worn down the valleys have a gentle grade and are quite wide, so that they make good trail routes. Routes crossing the mountains are usually expensive and contain steep grades. Foothill routes are undesirable, because there is so much winding in and out of the heads of cañons, to keep an even grade, that the trail becomes extremely long.

Factors which influence the building and cost of trails are: 1, grade; 2, width of the cleared space and the tread; 3, nature of soil; 4, cost of labor; 5, distance for packing supplies; 6, distance men have to walk to the work; 7, cost of supplies; 8, supervision. Grade is the determining factor. The cleared space varies from 6 to 14 ft., and the tread from 1 to 4 ft. Ordinarily a tread of 18 in. is wide enough, for a horse will almost invariably travel on the lower side of a trail and always in the same place; if the trail is wider, the inside will fill up with sliding material and the extra cost in excavation will be thrown away. On turns, trails are widened and on switchbacks the width is doubled. The trail bed should be flat. Excavation should be made into the bank instead of building up the outer side of the trail, because on steep slopes earth thrown out of the trail makes a poor footing. The supervision of the crew is a most important factor, for if the work is not arranged as it should be, the trail will be expensive under the most favorable conditions.

The size of the crews varies from 2 to 15 men. In crews of 8 to 15 men it is

*From a paper by Ernest Wohlenberg in the Forest Club Annual of the University of Nebraska. Reprinted in the August number of "American Forestry," Washington, D. C.

necessary to have a cook, a packer, and a foreman. The brushing out can be done by 2 to 4 men, while 5 to 8 can do the grading. Small crews vary from 2 to 5 men. The men do their own cooking and a ranger has general supervision over the work. The tools ordinarily used are axes and brush hooks for brushing out; cant hooks and peavies for moving logs; shovels, picks, and mattocks for grading. Where small crews are at work and the slopes are not too steep the trail is brushed and blazed, and left in that condition for travel to cut out the tread. A method similar to this was followed in connection with the Gila reconnaissance work in New Mexico in 1911. The reconnaissance party was working in a fairly open country in which there were scarcely any trails. The packers were sent ahead to locate a route to the next camp and to blaze and brush out the trail to a width of about 4 ft. Then when the pack outfit, which consisted of about 18 burros and 2 horses, went over this route, it would be fairly well cut out so that with a little extra work a good trail could be built.

On side-hill locations where water will run down a trail, it is always best to put in water bars; that is, small ditches 2 to 4 in. deep, running diagonally across the trail and banked on the lower side with earth or a small log sunk a few inches in the ground. These will turn the water and prevent any great amount of washing, which might ruin a trail. The number of water bars will vary with the grade of the trail and the degree of slope of the side hill. It is much cheaper to put them in when building the trail than afterward. Under ordinary conditions they can be located from 150 to 225 ft. apart.

In locating a trail, cliffs and rocky outcrops should be avoided because powder work is very expensive. Occasionally when a trail affords so many advantages that a high cost is permissible a good deal of rock work may be done. In building a trail, the country should first be reconnoitred and the route fully decided upon. It should then be located by stakes or blazes, and cleared and brushed, after which it will be graded and the tread formed to the specified width. Signs showing distances from important points and from water should be put up every mile if possible, and never less than four or five miles apart.

Forest Roads

The roads are built for freighting, logging, stage lines, pleasure traffic, or fire lines. Freighting is a very important item where camps and towns in a forest are located at a distance from the railway. Where logging is going on in the Rocky Mountains, roads must be built on account of the extreme roughness of the country. Roads, because of their width, are well adapted for use as fire lines. In more level regions fire lines can be used as roads.

Freight roads and stage roads as a rule should be well built and kept in good condition; and if there is a great amount of traffic they should be of double track width or have turnouts at intervals. For logging purposes, construction is not so important, as the road is abandoned as soon as the timber is cut. The maximum grade for the former roads should be 7%; for a logging road, especially where all logs are hauled down hill, the maximum grade may be greater but should rarely exceed 12%, and then only for short distances. Where roads are used for fire-lines and fire protection is more important than traffic, the only work necessary is that of clearing the space.

The location of a road is more important than that of a trail, because the former demands an easier grade and requires a greater amount of money in its construction. Since grade is the determining factor in locating roads a transit should be used because of its accuracy. Heavy rock work and the construction of bridges should be avoided on account of the expense. Side hills are the best for location since they are driest, have the best drainage and the best surface, and require less repairs, although the grading at the beginning will probably cost more. Routes of avalanches should be avoided, also routes in deep cuts, because the latter will fill up with snow. Switchbacks should not be used, for the sharp turns are not adapted to wagon traffic. The cost of road location varies from $5 to $50 per mile.

The factors which influence the cost of roads do not vary a great deal from those affecting trails. They are: 1, grade; 2, width; 3, amount of brushing out; 4, amount of grading; 5, drainage; 6, rock work; 7, distance for hauling supplies; 8, cost of labor, and 9, supervision. The maximum grade for most roads is from 6 to 7%.

The width of the roads varies from 8 to 12 ft. for single track and 16 to 20 ft. for double track. The width naturally affects the amount of brushing out. In heavily timbered localities the clearing is a very expensive item, as it is difficult to remove the stumps and to roll the logs out of the way. The amount of grading is a factor which influences the cost, depending on the steepness of the hillside and the number of stumps to be removed. A road should be so built that it is well drained; side ditches should be put in, with cross drains every 100 to 200 ft. In cheap roads the drains will not be covered, while in well built roads, culverts or rocks or wood should be put in. Rock work cannot be avoided as readily in road as in trail construction, and adds much to the expense. The supplies will be hauled by wagon, which costs only about one-third as much as by pack horses, hence the distance is not as important as in trail work. The cost of labor will affect road building the same as trail work. Supervision is the most important factor.

In constructing roads, stumps and rocks should be removed by using powder or dynamite, as this method is much cheaper than by manual labor. All work possible should be done by teams, since hand grading is very expensive on account of the large amount of material to be removed. In building single-track roads, turnouts should be built about 50 ft. in length so that vehicles can pass each other. The length of the intervals between turnouts would depend entirely upon the amount of travel expected on the road. In grading there should be more fills than cuts, because fills will drain better.

Drainage is an important item. On level ground both sides should be ditched to a depth of about 1 ft. and a width at the top from 2 to 3 ft. On hillsides the road should slope toward the hill, with a ditch on the inner side. In swampy places, a ditch 2 ft. deep and 2 ft. wide should be put on each side and a fairly high crown left in the center if possible.

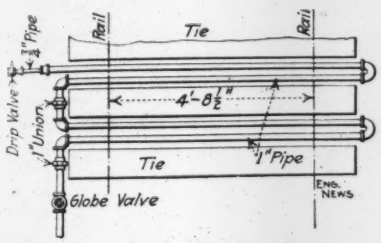
Forest roads, as a rule, are single-tracked, and from 8 to 10 ft. in width, with a maximum grade of 6 to 7%. The figures given by Mr. Greeley, of the U. S. Forest Service, for the cost of roads in District I, are from $100 to $1000 per mile, with an average cost of about $500 per mile.

Melting Snow at Switches: Erie R.R.

In order to keep snow clear of track switches at terminals, etc., the Erie R.R. uses loops of steam piping placed under the rails and connected to main pipes. The general arrangement is shown in the accompanying cut. The following particulars in regard to the installation are taken from the instruction card issued by the railway, this being one of the series of "standard practice" cards for maintenance-of-way and structures:

Installation — The installation consists of 1-in. pipe; two pipes are joined to each other by means of a return bend, thus making a unit which extends over the full length of the ties, as shown. One unit is placed in each space between ties, the units being coupled together by means of 1-in. unions. Four to six units are used at each switch, under the portion where the point rail engages the stock rail. The size of the lead pipes is as follows: 1 in. for one to three installations; 1½ in. for installations of four to eight switches in series; 2 in. for 9 to 15 switches in series. In no case should more than 15 installations be connected in series.

Each switch installation has a separate ¾-in. steam trap, and the pipe is laid



ARRANGEMENT OF STEAM PIPES FOR MELTING SNOW AT SWITCHES; ERIE R.R.

so that the drip is at the lowest point. Each switch installation has a 1-in. globe valve, and each lead pipe has a globe valve of the same size as the pipe. The steam pressure is required to be not less than 10 lb. at any point from which a lead is taken from the main steam line.

OPERATION — At starting, the steam valve is slowly opened wide, and each installation regulated by means of the steam trap so that only hot water escapes. When shutting off, each switch installation must be blown out and uncoupled to prevent freezing.

Organization of a Roadmaster's Division*

BY A. M. CLOUGH†

A roadmaster or supervisor of track is in charge of and directly responsible for the roadbed, track and entire right-of-way and land of the company on his division or subdivision. At the same time he is indirectly responsible for buildings, bridges and structures, as he is constantly in the territory and in touch with sudden defects or any changes in structures, etc., and reports same to the proper department. The organization of the staff and force of the roadmaster should be as outlined below.

ASSISTANT ROADMASTERS—An assistant roadmaster or supervisor must be capable of handling every detail of maintenance and such construction work as the subdivision is called upon to do. As it is from these men that the future roadmasters are appointed, he should also know the workings of the office accounts, supplies, correspondence, etc., and should be in touch with the foremen and working forces on the division.

There should be also a second assistant, who should be an engineer and familiar also with the office work. He should handle all matters pertaining to the engineering part of the subdivision; make drawings and estimates of proposed sidings or extensions, make survey and set stakes for the work, and make himself familiar with the construction and maintenance of track with a view to promotion.

CLERK—A competent clerk is required, with necessary assistants, to keep a complete record of all material on hand and voucher all bills as soon as material is received and found to check with invoice. He must render requisitions each month; also forward reports covering wrecks, derailments, personal injuries, fires, damage to property, live stock injured or killed, broken rails, etc., and make other daily, weekly and monthly reports incidental to the work.

The clerk must write the pay rolls, using particular care to scrutinize the foremen's time-books for any errors or omissions, issue discharge checks for men laid off or discharged, and keep all time-books filed for easy reference. As a pension record is retained for all persons occupying positions above that of laborer, a complete record should be kept of every change of occupation, rate of pay or transfer of all such employees. He must keep foremen advised as to method of handling time of their men, and making accurate report of material received and disposition of same.

As a clerk must handle all correspondence he should inspect all mail received and keep in touch with the file records. He should receive remuneration enough to insure a capable, accurate man, preferably a stenographer. He should have sufficient executive and business ability to conduct the office and to relieve the roadmaster almost entirely of this part of the work so that he can devote his entire time to the work on his division.

STOREKEEPER—The storekeeper takes charge of the storehouse, personally checks material received and keeps an accurate account of tools and material sent out. He should see that a complete stock of tools and material is kept on hand at all times, using proper discretion in ordering to eliminate as far as possible any surplus material. He should be in a position to know at all times what tools and supplies are at division headquarters, and as far as possible at different points on the division, to facilitate the work of securing the same as quickly as occasion demands.

He must keep the stock ledger complete and up to date, assist in clerical work in the office, and acquaint himself with method and manner of rendering reports. He should familiarize himself with the position in order that he may be competent to become a supervisor's clerk when he receives promotion.

MECHANICS—These will include the following: 1, a mechanic to erect and take care of pneumatic and mechanical crossing gates, mail cranes, signal bells and interlocked switches and signals not cared for by the signal department; 2, a carpenter and painter to repair and keep in order hand and push cars, whistle posts, crossing signs, sidewalks, etc.; 3, a blacksmith and helper to repair and sharpen track tools, make light repairs on frogs, switches and switch stands, and other iron work; 4, an engineman to run the steam derrick, road roller or any other engine when occasion requires. All men included in this clause must be capable of handling snow equipment such as flangers, snow plows, rotary plows and snow removers, when this equipment is in demand.

GARDENERS—A staff of garden laborers under a competent head gardener will take care of lawns and plant shrubs, propagate and set out flowers, and take care of the improved property of the company, besides assisting in any emergency work.

FENCE GANG—A fence-gang foreman with enough laborers will build, rebuild and keep in repair all fences, gates, wing panels and highway fences. They will do painting in spring and fall, heavy ditching in summer, and in winter be used as an emergency gang to shovel snow and primarily assist the section gangs where track tanks are located.

WORK-TRAIN GANG—The work train will be in charge of a regular work-train crew and a foreman with a specified number of men winter and summer to do all sorts of loading and unloading of track material, coal for pumping stations, handling cinders and other ballast, snow equipment, flangers, etc., in winter and be in readiness at all times to respond when called upon to clear wrecks or other blockades of the line.

EXTRA GANGS—The extra gangs will be in charge of capable foremen (who should be drawn from the most competent section foremen) to do all kinds of heavy repair or construction work, such as relaying rail, putting in gravel or stone ballast, and constructing or extending sidings or yards when such work is done by the maintenance-of-way department.

SECTION FOREMEN AND LABORERS—Most important of all are the section forces, the poorest paid and least appreciated of the entire working forces of the railway service. Section foremen must be above the average of intelligence, alacrity, judgment and resourcefulness. They must be in good condition physically, must be of good habits, and have the faculty of gaining the good will of the farmers and the traveling public. As the fences, crossings, gates, driveways and station grounds are under their jurisdiction they must know not only how to maintain and preserve the property but perfect it and in a large measure develop all the functions of skilled workmen. The foreman must choose the best workmen to do their work and must select particularly the trackwalker, who is chosen for his trustworthiness and reliability.

It has been found advantageous and mutually beneficial to both foremen and clerical force to have all foremen (about six at a time) visit the supervisor's office

*Abstract of a paper in the June number of the "Bulletin" issued by the Roadmasters and Maintenance of Way Association, Sterling, Ill.

†Supervisor of Track, New York Central & Hudson River R.R., Batavia, N. Y.

and attend a "school of instruction" conducted by the assistant roadmaster or supervisor and clerk for the purpose of standardizing methods of making out reports, giving them an insight into office methods and accounts and the necessity of giving full and complete detail of all work performed.

Maintenance of Way Organization on the A., T. & S. F. Ry. System

The new book of rules and regulations for the maintenance of way and structures on the Atchison, Topeka & Santa Fé Ry. System contains an interesting chart which shows diagrammatically the principle of the organization. This chart (re-drawn and enlarged) is shown in the accompanying cut. It will be seen that the organization is on the divisional system, the control of the maintenance-of-way and structures being lodged with the superintendent and distributed through four branches of his division organization: 1, division engineer; 2, roadmaster; 3, general foremen of bridges, buildings and water service; 4, division signal foremen. The division engineer reports to the engineer of grand division as well as to the superintendent. The division signal foremen report also to the signal supervisor as well as to the superintendent. The duties of the other division officials are outlined as follows:

ROADMASTERS—These have charge of and are held responsible for the maintenance and condition of the track, roadbed, culverts, crossings, fences, cattle-guards, and for the neat and tidy appearance of station grounds, buildings, and surroundings; also for the safe keeping of all material and supplies for use in the roadway department.

GENERAL FOREMEN OF BRIDGES AND BUILDINGS—These have charge of and are responsible for the condition of all bridges, trestles, culverts, viaducts and tunnels; also all buildings, including depots, platforms, shops, roundhouses, turntables, coal chutes, water and oil tanks, water and oil pumping plants, section houses, station houses, etc.

DIVISION SIGNAL FOREMEN—These are responsible for proper care of all signal appliances and have charge of all signal foremen and maintainers on their territory. They instruct signalmen as to the proper operation of plant. They receive instructions from the signal supervisor in all matters pertaining to standard designs or methods to be followed in the construction, maintenance or repairs of signal apparatus. They keep signal maintainers and foremen of signal repair gangs supplied with necessary material, supplies and tools for the proper handling of their work.

They make necessary requisitions for maintenance material and supplies for the superintendent's approval, and order necessary material for extensive repair work from detailed lists furnished by the signal supervisor. They will render monthly time reports and monthly report of the cost of material and labor used in maintenance work to the superintendent, with such other regular or special statements as may be required. They also check and approve all regular and special inspection reports on the condition of apparatus, and make such personal inspections and reports as may be determined by the signal supervisor, sending copies of all such reports to the signal supervisor and the superintendent.

A 1,000,000-lb. two-screw testing machine has been built by the Riehlé Bros. Testing Machine Co., of Philadelphia, for the American Steel Foundries, Alliance, Ohio.

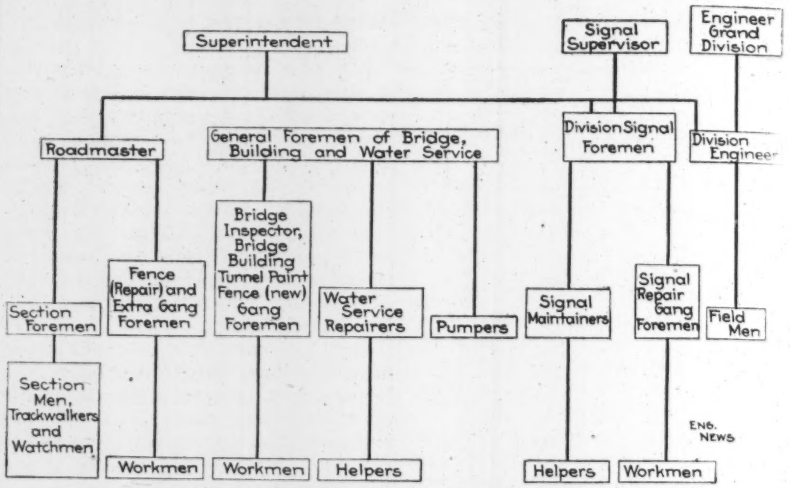


DIAGRAM OF ORGANIZATION FOR MAINTENANCE OF WAY AND STRUCTURES; A. T. & S. F. RY SYSTEM

A Sewer Made of Radial Chimney Brick

BY THOMAS PEALER*

The accompanying illustration shows a 5-ft. circular sewer built of radial chimney brick. The work was done largely as an experiment to gather cost data, to devise the best means of construction, and to prove the adaptability of the brick for this purpose; only a short length was built. The sewer was laid in the Borough of Indiana, Penn.

*Borough Engineer, Indiana, Penn.

The blocks were laid on a 6-in. cinder fill on the bottom and set to a true circle by use of two semicircular templates. The lower half of the sewer was completed before any of the top section was laid. A coating of cement and sand grout was washed into the joints of the invert after completion of the lower section. For setting the bricks in the arch a semicircular form 8 ft. long with a roller at each end was used.

The total length of the sewer is 190 ft., and the excavation required was about 100 cu. yd. The cost of labor was $2 per day, bricklayers $5, and teams $4.50 per

FIVE-FOOT SEWER MADE OF RADIAL CHIMNEY BRICK, INDIANA, PENN.

day. Cement cost $1.30 per bbl. and sand $1.74 per cu.yd. The radial bricks were made by the Clymer Brick & Fire Clay Co., of Indiana, and cost $4 per ton.

COST OF SEWER

	Per lin. ft. of sewer
Brick 784 lbs. + freight ($0.27½)	$1.83½
Hauling	0.18
Mortar	0.35
Laying	1.00
Excavation	0.30
Cost of Form	0.10
Supervision	0.25
	$4.01½

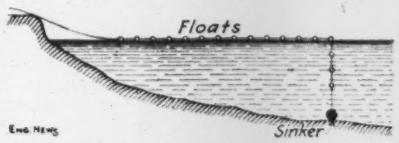
This does not include the cost of backfilling, which amounted to very little.

An Ingenious Method for Taking Soundings

BY M. H. FERGUSON*

A short time ago an interesting problem came up in the location of an athletic field for the Worcester Boys' Trade School. We were contemplating filling in a portion of a pond with a limited amount of material, and were required to make the fill of a prescribed width and height. This, of course, necessitated taking soundings over the area to be filled, to ascertain the depth of water in different places, and to make sure there were no large holes in the bottom to consume too much of the material. The area to be filled in varied in width from zero to 60 ft. and was, roughly speaking, in the form of a segment of a circle.

There was no boat to be found, so the following method was devised for taking soundings. The apparatus used consisted of a ball of stout cord, 17 small wooden balls for floats, and an iron ball for a sinker. First we made sure that the weight of the iron ball was sufficient to sink all the wooden balls combined, then attached the iron ball to the end of the cord. Next we fastened one of the wooden balls to the cord at a distance of just 4 ft. from the iron one, by means of a heavy staple, and then for every foot of cord we attached a wooden ball until they were all in place. Thus from the iron ball to the last one of wood was a space of 20 ft., which we thought ample for the greatest depth we would find. Our 20-ft. flexible depth gage was then ready for use, so we took it to the edge of the pond, laid it out carefully to prevent snarling, and cast the iron ball out to the outer edge of the fill, a distance of about 60 ft. The number of balls floating on the surface were then counted and, as each one represented 1 ft. on the cord, by deducting this from 20 we obtained the depth at that place. The line was then drawn in a few feet and allowed to rest for a moment in order to bring the cord to a vertical position and the counting done as before. This was repeated from different points along the shore and the results tabulated until quite a fair approximation of the depth of water was obtained over the entire area to be filled. While this, perhaps, was a rather crude and unscientific affair it served the purpose at the time quite acceptably and enabled us to get around a difficulty that otherwise would have proved very troublesome.



APPARATUS FOR TAKING APPROXIMATE SOUNDINGS

*Instructor, Worcester Trade School, Worcester, Mass.

A Convenient Method of Plotting Soundings in Hydrographic Surveys

BY EDWARD PARRISH*

A method of plotting soundings in hydrographic surveys based on the principles described by Maj. R. R. Raymond in ENGINEERING NEWS of Sept. 26, 1912, has been very effectively used in the U. S. Engineer Office at Newport, R. I., since 1888 and was explained to the writer by Col. W. R. Livermore, Corps of Engineers U. S. A., retired, who was at that time in charge of the Newport office. This method differs from the method described by Maj. Raymond in that it provides for the plotting of the located points of a line of soundings without the use of drafting instruments, other than a lead pencil, and the points may be plotted the moment the sextant observers call out their angles.

The method here described enables the chief of party to have before him, as the work proceeds, an exact record of the area covered, and shows whether he he is leaving any considerable areas uncovered, or is bunching his soundings too much in any one locality, a consideration of great moment when work is carried on at long distances from shore or in a locality where shore ranges are not available, or in running on compass bearings in tidal currents or varying winds.

In the triangulation for the survey three or more points are carefully located in such positions that they may be clearly seen from the sounding boat. Through each succeeding pair of established points there are then drawn circles which are the loci of even degrees, half or other fractions of degrees, subtended by the two points under consideration and covering that portion of the entire area to be sounded, upon which it is expected to use the two points in question. The number of the fractional degree circles will be dependent upon the scale of the map; usually the half-degree circles serve the purpose, for the intermediate minutes can be very closely estimated. In Fig. 1, illustrating the character of sheet used, the circles are for 5° angles only, on account of the smallness of the sketch.

In practice only so much of the arcs of the circles as are included within the boundary of the area to be surveyed are drawn in permanent form on a sheet covering the whole area, tracings are then made of these arcs in sections of such size that they may be conveniently handled in the boat without having a long roll to handle, which is decidedly inconvenient in windy weather or rain. As many blueprints, or other prints, as may be desired are made from the tracings and when tacked to a small drawing board are in a convenient form to handle on the work. The shrinkage of the print is of no particular consequence, as it merely serves to alter the scale slightly.

The notes of the survey are recorded as usual, and when it comes to the final map, a sheet of tracing cloth is laid over the original drawing of the circles and the lines of soundings are plotted as fast as they can be read off from the note books, no angular measurements beyond

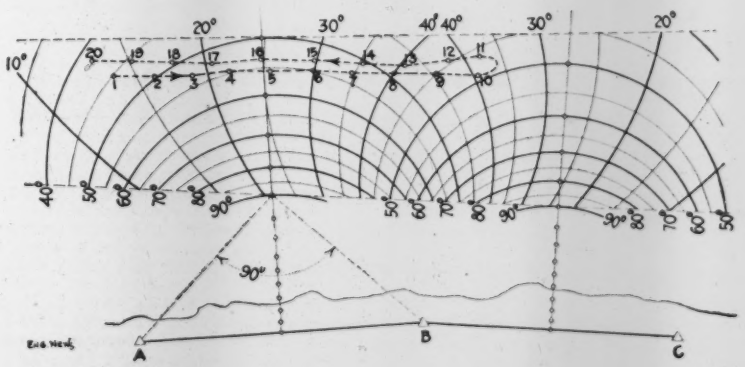


FIG. 1. SOUNDINGS PLOTTED BY METHOD OF INTERSECTING CIRCLES WITHOUT THE USE OF INSTRUMENTS

*Assistant Engineer, U. S. Engineer Office, Newport, R. I.

those originally made in drawing the circles being required.

The basis of this method of plotting is in the graphical solution of the three-point problem illustrated in Fig. 2: Having three points *A*, *B* and *C* located on shore, and a point *E* from which the angle *a* is read between *A* and *B* and the angle *b* between *B* and *C*, the position of *E* is required. The circle through *A*, *B* and *E*, or that portion of it on the same side of *AB* as *E*, is the locus of all points from which the angle between *A* and *B* will be *a*. Similarly with respect to the angle *b* between the points *B* and *C*; so that the intersection of these two circles gives the position of the point *E*.

In the preparation of the diagram for plotting the position of the line of soundings the angles *a* and *b* are taken as even degrees and fractions of degrees and the positions of the centers of the corresponding circles are on a perpendicular to the line joining the fixed points at its middle point and at a distance from it equal to half its length by the cotangent of the angle, or ½ *AB* (or *BC*) × cot *a* (or *b*), or this center may be constructed as described by Maj. Raymond. Using this simple formula and a slide rule the centers are very rapidly found.

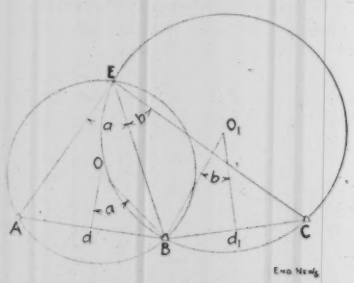


FIG. 2. GRAPHICAL SOLUTION OF THREE-POINT PROBLEM, SHOWING METHOD OF CONSTRUCTING CIRCLES

In Fig. 1, for example, the circles drawn through *A* and *B* are the loci for angles of 20°, 25°, 30°, 35°, etc., up to 90°; and through *B* and *C* for angles of from 10° to 90°. The dotted line in Fig. 1 represents a plotted line of soundings in which the position of point No. 1, for example, is located by an angle between *A* and *B* of 45°, and between *B* and *C* of 13° 50′; point No. 6 by angles of 55° between *A* and *B*, and 30° between *B* and *C*, etc.

When the circles are drawn for half degrees on any ordinary scale it leaves very little to be estimated for odd minutes in the readings. The first drawing of the circles serves for the conduct of the field operations, for the final plotting of the map, for any subsequent improvement which may be based on the survey, and particularly, if a dredging operation, in the final examination of the dredged area and cleaning up shoal spots that may have been left during the work.

Notes

An Example of Wild Bidding on the part of one contractor and remarkably close bidding by others is to be found in the bids submitted for the South Eighth St. Viaduct in Allentown, Penn. The six lowest bids on this structure were, respectively, $306,000, $306,200, $310,400, $339,070, $340,000, and $360,500, while a seventh bid by a reputable concern was $617,965.

The Industry of City Day Laborers may be greatly increased by special circumstances. Even efficiency experts would have been astonished at the remarkable diligence displayed by some city sewer cleaners at Indianapolis, Ind., a few days ago, as related in the "Indianapolis News." As the matter excavated from the sewer was emptied into a wagon, one of the workers had spied a glittering object, which turned out to be a goldpiece. Further search brought to light about $26 in coins, considerable jewelry, including two diamond rings, and in addition to other valuables, 27 shovels were found in the sewer! It seems there was an obstruction in the main sewer at this place, and the "money and jewelry mine," as the laborers called it, was the accumulation of objects which are believed to have found their way into the sewer in snow cleaned from the streets and dumped into the sewers during the winter.

Testing a 66-in. Cast-iron Pipe used in the siphon under the Don River in connection with the new high level intercepting sewer at Toronto, Ont., is described in a report of the City Engineer of that city, issued not long since, as follows:

The section of pipe tested weighed 9038 lb., measured 8 ft. in length and 66 in. in inside diameter, and was made of 1.5-in. thickness of cast iron. A pit was excavated 8x11 ft. and 8 ft. deep. In this were laid three sills 10x10 in. x 11 ft., and on them two caps 8x10 in. x 8 ft. were spaced 4 ft. apart, c. to c., and so placed as to lie 2 ft. from each end of the pipe, this construction being similar to that adopted in the actual work on the siphon. On each cap two bearing blocks were fastened supporting the pipe at two points 35 in. apart horizontally. The pipe was lowered into place by jacking, on the ends of a 10x10-in. timber placed through the pipe. The spigot end was placed tight against the end of the pit, and a bulkhead was built around the flange end, so that when the back-filling was completed, access could be obtained to the inside of the pipe. The back-filling was composed of clayey sand excavated from the river bed, was thoroughly wetted and tamped and brought to a height of 6 in. above the top of the pipe. On top of this a skeleton platform of 2-in. planks was laid to form a foundation for the pig iron, which material was to be used for the load.

The pile of iron was commenced on a base measuring 7 ft. 7 in. by 4 ft. 8 in. Two tiers, 4.1 tons, were laid before the gages were set. These were three in number, two being used to measure contraction on the vertical diameter at the flange and spigot ends, and the third to measure expansion on the horizontal diameter midway between them. They were of simple construction; an oak rod ¾ in. square fitted with a metal bearing point at the bottom and having fixed at the top a rule inset in which was a graduated metal slide, on which readings could readily be made to 1/64 in. Depressions were made with a center punch into which the gages were set. The load was increased by increments of one ton (50 pigs approximately), and at each increment the gages were read. The total load applied was 33.1 tons, and the test took approximately two days. The deformation occurred uniformly to the extent of approximately 1/64 in. per ton at the spigot end, one-half as much at the flange end, and one-half the difference midway between.

It had been the original intention to take readings as the load was decreased, but circumstances would not permit of this. Two readings were, however, obtained, one being made just after the load had been removed, and the other after the filling had been removed. The former showed that the pipe had returned from a total deflection of 25/64 in. at the spigot end to within 6/64 in. of its original diameter, and from a total deflection of 23/64 in. at the flange end to within 3/64 in. of its original diameter. The latter showed the pipe in its initial shape.

Heading Rivets by Rolling is done by a machine built by Boye Bros., Berlin, Germany. The rolling process is intended to be used on thin plate work, with rivets up to ⅝-in. diameter. The machine is similar to a drilling machine. The spindle carries a two-pronged stem, bearing two rollers set close together. The faces of the rollers are tapered or concaved, and together outline the contour of the rivet head. The base of the machine carries an anvil or set to receive the head of the rivet, the work being laid over this anvil. The anvil is raised by a pedal, and thus the end of the rivet is pressed against the rollers in the spindle, and a head is formed as the spindle rotates. This machine was noted in a recent issue of "Der Eisenbau." One claim in its favor is that the rivet can be headed without pinching the plates, which may be useful in riveting up link chains and similar work.

California Highway Bridges—The California Highway Commission recently formulated minimum dimensions and loadings for bridges and culverts (except such as carry street railways) built for the state highways. At the same time that it adopted this specification, the Commission also declared its preference for concrete structures, because of their substantial permanency. The standards are as follows:

(a) All such structures are to be designed by competent engineers and the plans, specifications and workmanship be subject to the inspection and approval of the Highway Engineer of the Department of Engineering.

(b) The width of such structures, exclusive of sidewalks, if any, shall be not less than 21 ft. in the clear.

(c) Concrete bridges shall be designed to sustain, in addition to the dead-load, a uniform live-load of 150 lb. per square foot of roadway and the floor system to carry a 20-ton traction engine.

(d) Steel bridges of span less than 150 ft. shall be designed to sustain, in addition to the dead-load, a uniform live-load of 100 lb. per square foot of roadway and the floor system to carry a 15-ton road roller; for spans in excess of 150 ft., a uniform live-load of 85 lb. per square foot of roadway, the floor system to carry a 15-ton road roller as in the case of spans of less than 150 ft.

(e) Trestles shall be designated to sustain, in addition to the dead-load, a uniform live-load of 150 lb. per square foot

of roadway, and the floor system to carry a 15-ton road roller.

Susceptibility of Trees to Lightning stroke does not appear to depend on species, but chiefly on locality, height of tree, relative number of different species, etc. A recent Bulletin of the Forest Service, by F. G. Plummer ("Lightning in Relation to Forest Fires," Bulletin 111; Superintendent of Documents, Washington, D. C., 10c.) discusses the subject fully and gives the results of investigations. The conclusions of the study are:

1. Trees are the objects most often struck by lightning because: (a) They are the most numerous of all objects; (b) as a part of the ground they extend upward and shorten the distance to a cloud; (c) their spreading branches in the air and spreading roots in the ground present the ideal form for conducting an electrical discharge to the earth.
2. Any kind of tree is likely to be struck by lightning.
3. The greatest number struck in any locality will be of the dominant species.
4. The likelihood of a tree being struck by lightning is increased: (a) If it is taller than surrounding trees; (b) if it is isolated; (c) if it is upon high ground; (d) if it is well (deeply) rooted; (e) if it is the best conductor at the moment of the flash; that is, if temporary conditions, such as being wet by rain, transform it for the time from a poor conductor to a good one.
5. Lightning may bring about a forest fire by igniting the tree itself, or the humus at its base. Most forest fires caused by lightning probably start in the humus.

Wind Pressure Concentrations—The official specifications for the design of steel framework in Prussia have recently been amplified in the matter of wind pressures. For the wind-bracing, as a whole, the wind pressure on the whole building is to be taken as 17 lb. per sq. ft. For proportioning individual frame members, girts, studs, trusses, etc., a higher value of wind pressure must be assumed, viz., 28 to 34 lb. per sq.ft. This ruling appears to be equivalent to the assumption that the wind pressure does not have maximum pressure simultaneously over large areas. The same principle of design applied to the verticcal wind truss of a tall building would require the bracing of the upper section to be proportioned for full wind pressure, and would allow the lower parts of the bracing to be figured for reduced pressure.

Painting the Saybrook Bridge—The new steel highway bridge over the Connecticut River at Saybrook, Conn., opened in 1911, is 1800 ft. long, made up of fixed spans of 122 ft. and 160 ft. and a 200-ft. rolling-lift draw-span. It is described in a paper by Edward W. Bush, Chief Engineer, in the 1912 "Proceedings of the Connecticut Society of Civil Engineers," with the following particulars as to the painting of the steelwork:

The shop coat consisted of Metal Red No. 1. The two field coats were made to the following specifications: (1) Pigment: ¾ white lead, ¼ oxide of zinc with a little lampblack to color; (2) Vehicle: pure linseed oil with a small amount of turpentine drier. The first field coat was a light brown color. The second and final coat was a very light gray color, almost white.

Three requirements largely influenced the selecting of this light finishing color: (1) something that would look well with the surroundings; (2) a color that would show up well at night under the rays of searchlights from river boats; and (3) a color that would quickly show rust in the event of the bridge being neglected. The bridge is owned by the state, and as Connecticut has no state organization of technical men who are charged with the care and maintenance of such a structure as this, the bridge may be neglected as to painting at some future date. It was thought that the bridge would be more apt to receive a coat of paint if the rust shows up strongly against a light color, than it would if the same amount of rust was more or less concealed because the structure had been given a dark color.

Breakdown Flashboards for Dam—The well known McCall Ferry dam across the Susquehanna River at Holtwood, Penn., is provided with a novel type of flashboard, to gain additional storage height, in which the main members are steel pins designed to bend at a given pressure and let down the boards when the height of water held becomes too great for the dam and its pond to retain safely. There are grouted into the crest of the concrete dam throughout its 2500 ft. length some 940 pipe bushings, each 2½ in. in diameter and 18 in. long and spaced about 2½ ft. c. to c. These bushings form sockets for holding steel pins 6 ft. long, 2½ in. in diameter and notched just above the bushing to 1⅞-in. diameter. Against these pins the wooden flashboards are placed to a height of 4½ ft. The notched pins are designed so as to bend over when the height of water above the original crest is between 5 ft. 6 in. and 5 ft. 9 in. By reason of the breaking of the flashboard joints between pins the bending takes place uniformly across the dams, allowing the flashboards to float downstream and releasing the water to normal height. After the flood has subsided new pins and flashboards are placed by a barge provided for the purpose. Although the pins and a large part of the flashboard are lost, it is considered that the cost, on account of the infrequency of floods, is less than it would be for some more complicated type of tipping flashboard.

A Power Winch for Car Spotting is now in daily use in the shops of the Stephens-Adamson Manufacturing Co. of Aurora, Ill. The winch has a cast-iron case provided with gear teeth on the inside so as to form an internal spur gear. A train of planetary gears connected to the winding drum meshes with this internal gear and with a small pinion which is keyed to the driving pulley shaft. The gearing is designed to give a considerable reduction between the drive shaft and the winch so that a slow powerful movement is obtained without the use of a large motor. In use, the rope attached to the car to be started is given two or three turns around the drum. Then by pulling on the free end of the rope the operator can cause enough friction between the rope and the drum to move the car. The release of the rope end instantly releases the pull of the winch.

The Stephens-Adamson Co. has arranged to put this winch on the market under the name of the S-A car puller. It is made in two sizes, one (with horizontal drum) capable of hauling three loaded cars, and the other (with vertical capstan) able to handle five loaded cars on a level track. Both sizes are arranged for electric motor drive, or when used within a shop they may be belted to a line shaft provided with a clutch pulley.

Library Methods of Indexing are recommended to engineers, as solving a much discussed problem, by L. J. Foley, in the Sept. 26 issue of the "American Machinist." Mr. Foley writes in part as follows:

Standardization rules have been adopted in many lines of engineering, but engineers in general have not been informed that library methods have also been standardized. The vexing problems which they are endeavoring to individually work out, as indicated in the variety of solutions appearing in the technical journals, have been tried out, solved and reduced to a working science by library experts.

The problem of the engineer in classifying, cataloging and indexing his material is not a problem of devising methods, but of how he may become acquainted with standard library practice and apply it in his individual case. Every engineer knows the difficulty of keeping up notebook records and the time needed to keep up systems of clippings, filing and indexing.

The methods of subject classification of material and of card cataloging which originated in library practice, have been adopted and become permanent in all record keeping in the business world. All engineers and business men alike know the value of a card-index system for shop and office records. A similar record can be made proportionally as valuable in the catalog and periodical files.

The value of technical literature lies in the fact that before a man begins constructional or design work it enables him to become fully acquainted with the methods by which other engineers have overcome their difficulties. In this way he often gains an inspiration concerning an immediate and practical problem.

Printed Titles on Tracing Cloth—In getting out the enormous number of detail drawings required by the Board of Water Supply, City of New York, it was soon found that to letter all the titles by hand required a large expenditure of draftsmen's time. In a paper read by C. F. Bell at a meeting of the Municipal Engineers of the City of New York is found the following description of the method used in printing standard titles on drawings and tracings:

In printing the titles by the press, the drawing is laid on a rigid horizontal pad, around which a table has been built large enough to allow drawings to be laid out flat without danger of creasing, and the chase in which the type has been set is brought down on this. For a long time a sprinkling of either pounce or magnesia was applied immediately after the printing to hasten the setting of the ink, but both of these got on the men's clothing and gave the work a grayish appearance, while the titles never became either elbow or benzine proof, and it often happened that after much handling, the titles would have to be retouched and sometimes altogether renewed by hand. At one time we tried putting a thin coating of collodion over the titles instead of using pounce, but the resulting gloss prevented good photographic work, while the collodion soon lost some of its transparency and looked dirty. Then we tried using "Fixitif," a liquid used by artists for setting charcoal sketches, and we are still using it with most satisfactory results. A templet, made by cutting out the paper proof submitted by the printer, is placed over the title and a light coating of "Fixitif" is sprayed over the printing from an atomizer, no pounce being used. This coating is almost invisible, preserves the black appearance of the ink, which is of great advantage in photographing, and in a few hours (over night) the printed work is finger-proof and practically benzine-proof. The first sample job treated

this way has been hung up, exposed to the dust and air for several months and wiped several times with a benzine cloth with no noticeable change in appearance.

Cost Data on 8-in. Pipe Sewers—The accompanying table is taken from the Report of the New Orleans Sewerage and Water Board for 1911, and shows a detailed analysis of the cost of laying 8-in. pipe sewers by city day labor under supervision of the construction department of the sewerage board.

A Table of Square Acreage is sent to us by D. S. Perry, of Leesburg, Fla., who states that he has been able to save a great deal of calculation by having it with him in the field. The table may easily be extended to include greater ranges of area.

LENGTHS OF SIDES OF SQUARES FOR GIVEN ACREAGES

Acreage	Length of side of sq. in feet	Acreage	Length of side of sq. in feet
¼	104.4	5	466.7
½	147.6	5½	489.4
¾	180.7	6	511.1
1	208.7	6½	532.2
1½	255.7	7	552.2
2	295.1	7½	571.6
2½	330.0	8	590.3
3	361.5	8½	608.4
3½	390.5	9	626.1
4	417.4	9½	643.2
4½	442.7	10	660.0

COST OF 8-IN. PIPE SEWERS, CITY DAY LABOR, NEW ORLEANS, LA.

Size of Pipe	8 in.				
Depth of Cut, ft	0 to 6	6 to 8	8 to 10	10 to 12	12 to
Lin.Ft. Laid	8365.45	4442.41	11492.40	3339.[illegible]	870
Cost per lin.ft.					
Labor	$ 0.299	$ 0.318	$ 0.447	$ 0.629	$ 1.[illegible]
Material	0.185	0.169	0.305	0.299	1.[illegible]
Hauling	0.042	0.031	0.037	0.057	0.[illegible]
Paving	0.074	0.038	0.012	0.012	0.[illegible]
Salaries	0.042	0.049	0.082	0.150	0.[illegible]
General Expense	0.115	0.134	0.215	0.286	0.92[illegible]
Total	$ 0.757	$ 0.739	$ 1.098	$ 1.433	$ 3.[illegible]
Depth of Manhole, ft	0 to 6	6 to 8	8 to 10	10 to 12	12 to [illegible]
Number of Manholes	14	73	41	6	[illegible]
Cost per Manhole,					
Labor	$ 9.761	$ 11.116	$ 13.485	$ 16.198	$ 36.8[illegible]
Material	24.925	24.472	28.677	38.245	49.3[illegible]
Hauling	2.630	2.969	3.469	4.526	9.9[illegible]
Paving	1.810	1.388	1.769	3.120	0.66[illegible]
Salaries	1.230	1.230	1.230	2.250	2.46[illegible]
General Expense	3.340	3.340	3.340	6.123	6.68[illegible]
Total	$ 40.696	$ 44.515	$ 51.970	$ 60.462	$105.25[illegible]

Correction Tables for Strengths of Commercial Size Timbers

By R. C. Hardman*

Tables for the designing of wooden beams, based upon an allowable stress of 1000 lb. per sq.in. and showing safe loads and deflections on beams of varying depths and lengths, are familiar to all engineers. Such tables are accurate only for nominal cross-sectional dimensions and not for the real dimensions common in commercial lumber. For instance, practically 95% of the southern yellow pine on the market is classified and graded under the rules of the Southern Yellow Pine Manufacturers' Association, and in actual size is from ¼ to ⅝ in. smaller in dimension than called for by its nominal size. These variations, as standardized by the Association, are as shown in Table I, lumber designated "S1S1E" being surfaced on one side and one edge and that designated "S4S" being surfaced on four sides. Full-size stock can not usually be secured without a special order.

It is obvious that strength formulas applicable to nominal sizes will not give correct results for these smaller commercial sizes. For instance, standard tables show that a 2x4-in. yellow pine beam will carry for a 10-ft. span, with an allowable stress of 1500 lb. per sq.in., a safe load of 534 lb. Commercial 2x4's, S1S1E, are actually 1⅝x3⅝ in., and, S4S, are 1½x3½, which sizes figure safe loads of only 356 and 306 lb., respectively, decreases of 33% and 43% from the safe loads as usually tabulated. These percentages of decrease, which are very large in the smaller sizes, shrink to 6% and 12%, respectively, for a 12x12, for instance. In computing deflections the discrepancy is found to be still greater, as the deflection varies inversely as bd^3, while in stresses the variation is as bd^2. Thus for the beam given above, the increased deflections are approximately 40% and 50%, respectively.

In the case of struts, in which the end bearing only is considered, we find that a 4x4, for example, becomes a 3⅝x3⅝, or a 3½x3½, as the case may be, and will carry but 82% and 77%, respectively, of the load based upon the *nominal* size of a 4x4. If, however, the strut is long enough to be acted upon by combined compression and flexure, the variation becomes greater. For a 4x4-in. column, 10 ft. long, computed by Rankine's formula, it is found that the commercial sizes will carry but 70% and 62%, respectively.

To summarize:

jBeam, 2x4-in. 10 ft. long:
- Safe load, S1S1E.....33% decrease
- Safe load, S4S.....43% decrease
- Deflection, S1S1E.....40% increase
- Deflection, S4S.....50% increase

Strut, 4x4-in:
- Safe load, S1S1E.....18% decrease
- Safe load, S4S.....23% decrease

Column, 4x4-in. 10 ft. long:
- Safe load, S1S1E.....30% decrease
- Safe load, S4S.....38% decrease

To care for this error, the writer has prepared the accompanying Table II for his own use in designing. It is exact to the extent of a slide-rule check. Table I gives the *actual* sizes of the various nominal sizes of yellow pine lumber as given by the Southern Yellow Pine Manufacturers' Association. Table II gives factors by which the usual tabulated values of safe load should be multiplied to give the true safe loads for commercial sizes. As an example: In the case of the beam first given—2x4 in. x 10 ft.—the handbook tables show 534 lb. Multiply this value by 0.667 (Table II for S1S1E) which gives 356 lb., the actual value for a 1⅝x3⅝-in. x 10-ft. beam.

Similar tables for other varieties of woods and other commercial sizes can readily be made. In view of the increased, and very general, use of the smaller sizes in concrete forms, etc., and the growing tendency among engineers to design their forms instead of permitting contractors' foremen to "slap them up" in a haphazard manner, it seems that these corrections for commercial sizes of lumber are very pertinent, and demanded by the dictates of careful designing.

*Civil Engineer and Supt. of Construction, U. S. War Dept., Fort Huachuca, Ariz.

TABLE I. ACTUAL SIZES OF LUMBER IN INCHES.

(Southern Yellow Pine Manufacturers' Association.)

Breadth / Depth	2-in.	4-in.	6-in.	8-in.	10-in.	12-in.
For S1S1E:						
4-in.	1⅝x3⅝	3⅝x3⅝				
6-in.	1⅝x5⅝	3⅝x5⅝	5⅝x5⅝			
8-in.	1⅝x7⅝	3⅝x7⅝	5⅝x7⅝	7⅝x7⅝		
10-in.	1⅝x9½	3⅝x9½	5⅝x9½	7⅝x9½	9½x9½	
12-in.	1⅝x11½	3⅝x11½	5⅝x11½	7⅝x11½	9½x11½	11½x11½
For S4S:						
4	1½x3½	3½x3½				
6	1½x5½	3½x5½	5½x5½			
8	1½x7½	3½x7½	5½x7½	7½x7½		
10	1½x9½	3½x9½	5½x9½	7½x9½	9½x9½	
12	1½x11½	3½x11½	5½x11½	7½x11½	9½x11½	11½x11½

TABEL II. SHOWING FACTORS BY WHICH TABULATED VALUES OF SAFE LOADS ON BEAMS SHOULD BE MULTIPLIED

Breadth / Depth	2	4	6	8	10	12
For S1S1E						
4 in.	0.667	0.744				
6 in.	0.714	0.796	0.824			
8 in.	0.714	0.823	0.899	0.909		
10 in.	0.733	0.839	0.911	0.921	0.927	
12 in.	0.746	0.850	0.918	0.929	0.942	0.939
For S4S:						
4 in.	0.574	0.670				
6 in.	0.630	0.735	0.770			
8 in.	0.638	0.769	0.806	0.824		
10 in.	0.659	0.790	0.827	0.846	0.857	
12 in.	0.674	0.804	0.842	0.861	0.872	0.880

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*Illustrated.

Engineering News

River Improvement by Clearing

A refreshing novelty in local-improvement agitation comes from New Castle, Penn. The Board of Trade of that town has just passed a resolution urging the city authorities to improve the river channel in the city by clearing out obstructions and removing encroachments. The Board of Trade urges upon the city authorities

the imperative necessity of prompt action to increase the area of channel and the rapidity of flow in the Neshannock Creek and in the Shenango River, to the end that such destructive floods as have twice during the past year destroyed the property of its citizens, threatened the foundations of many of their most important buildings and the health of the entire city, may in the future be averted. We urge upon those authorities the prevention and removal by legal means of encroachments upon the channels of these water courses.

This resolution is a pleasant surprise, because it is radically different from what has been done and is being done elsewhere. The all but universal custom, when repeated floods work havoc in a community, is to resolve that the state, the United States government, or some equally remote authority, be urgently requested to at once alleviate the conditions, by building reservoirs or growing forests. It has been accepted as a matter of course that all local floods are caused by conditions far above the point of flood, and that the local community stands helpless before the visitation.

Without undertaking to criticize this idea, we may point out that nearly all cities, large and small, allow the channel of streams passing through them to be encroached upon without regard to the effect on flood heights, and in many ways create conditions under which the water's efforts to get past the city in a normal way are hindered as much as possible. The Board of Trade of New Castle is to be congratulated on its unusual common sense is recognizing this state of affairs.

Wanted: A Roofing Material

The campaign to educate the public in the fundamentals of sanitary science has occasional surprising results. We print below a letter of inquiry received recently by one of the government departments at Washington:

Please inform me specially of the addresses of manufacturers of roofing materials perhaps metals that are free from corasion and free from deteriation, that are suitable for residence roofs, the gutters down spouts, and suitable to line the cisterns, so as to have rain water entirely entirely free from contamination with cement and minerals used in making cisterns. If it were practical I would use insoluble materials in lining the cisterns, as insolubles are entirely impervious to water as vitrified enameled materials. My object is to free the rain water of gases that may have contaminated it when failing through the air, and free it of dirt that is shure to have blown on the roofs, and free it of bird droppings, bird manure on the roofs, and free it of everything foreign, except oxygen two parts and hydrogen one part, then keep it free from touching cement and soluble minerals, so as to have and keep pure soft rain water entirely free from contamination with soluble minerals and foreign matter for drinking and cooking yearly.

Please suggest practical water stills and water filters by sending the addresses of the same. What is the price per square of 100 feet to the square of metal roofing free from deteriation, send sample of the same. Also will you please inform me of the addresses of manufacturers of building materials that are suitable to use in making and building the entire exterior walls of residences and the roofs of the same, as the entire exterior sides and roofs, that the materials are practical and satisfactory and proves to be entirely water proof and weather proof and when tested proves to be entirely impervious to water, and proves to be entirely free from both corosian and deteriation. Thanking you for explainations, instructions suggestions, references, addresses and etc, as I am so anxious for the information.

The only metal we know of which comes anywhere near filling the above quoted specification is gold! The writer of the letter is by no means the first man who has failed to realize that what an engineer or constructor can do is limited by the materials available to work with.

The Passing of the Electric Heater on Street Cars

ENGINEERING NEWS has been alone among technical journals, so far as we are aware, in opposing the use of electric heaters on street and interurban cars, except in climates where the winter temperature is such that the amount of heat necessary to keep cars comfortable is comparatively small.

As we have frequently stated in these columns, our reason for opposing the use of electric heaters has been the very great cost of heat supplied in this way. Less than 10% of the fuel burned at the power house appears as heat in the cars. What is of much greater economic importance is the heavy draft on the power station resulting from the use of electric heaters in the winter months if the cars are kept reasonably warm. It has been demonstrated that to furnish enough heat to keep a car comfortable in severe winter weather will require a greater amount of electric current than is necessary to propel it. Conditions of overload on

power stations are frequent enough without the added burden of electric heating.

We note with interest that the position this journal has long taken on this matter is now finding support by the results of actual experience. The report just issued by the Public Service Commission of the State of New York for the Second District (which includes all of New York State outside of Greater New York, has the following comment concerning the use of electric heaters on street cars:

> The electric heater in cars is the cause of frequent complaints. With the present style and location of this class of heaters in either the longitudinal or cross-seat car it is impossible to obtain as perfect distribution of heat in the car as results from the use of air, steam, or hot-water heaters. On several of the roads cars are heated by air or water circulation. Economies are claimed for this manner of heating, and as far as the comfort of the public is concerned it is superior to the present method of heating cars by electricity. Discussion of this subject with several of the managers of electric roads justifies the prediction that the number of electrically heated cars will be materially reduced each year.

More Concerning the Shipment of Cement in Bulk

We have frequetly urged in these columns the great economic advantage of shipping and handling cement on large jobs in bulk instead of in bags. One of the largest producers of cement, the Universal Portland Cement Co., has now taken up the matter and issued a circular urging the advantages of shipping cement in bulk. When one computes the cost of all the items involved in packing and handling cement in bags, it is probable that a total saving of not less than 25c. per bbl. on the cost of cement could be saved by handling it in bulk instead of in bags. There is really no difficulty at all in shipping cement in tight box cars; and as was pointed out in these columns by a prominent cement manufacturer some months ago, if rain finds entrance to the car through the roof or sides, the damage to the cement will be less than if it were shipped in bags instead of in bulk.

Besides the economy to the cement manufacturer and user, it is worth while pointing out that from the standpoint of the quality of the product, engineers should favor the use of cement in bulk. The even aëration which bulk cement receives in handling from the car to the mixer will have the same effect in securing the certain hydration of any free lime particles that is sought by the specifications which require cement to be stored a certain time before using.

There is doubtless a certain prejudice in favor of the use of cement in bags because it is easy to get the right proportion of cement by counting the number of bags put into a batch of concrete. There is, however, always the chance that the man on the mixer may make a miscount and put in perhaps one bag too few so that there will be a lean batch of concrete turned out, or one bag too many, wasting cement. With cement in bulk, on the other hand, the proper amount of cement for one batch is measured just as the stone and sand are measured, and there is no chance for making an error. We are informed that bulk cement is now being shipped and used with great satisfaction and economy on some large contract work as well as in factories using cement in the manufacture of sewer pipe and other cement products.

Passenger Transport in London: The Comparative Economy of the Electric Railway and the Motor Omnibus

Suppose an engineer should publicly declare that the electric street-car system in any city of the United States was an economic mistake and that the public would be better served and the traffic would be moved at lower cost by the substitution of motor vehicles running on the pavement in place of the street cars. It need hardly be said that any such statement would be taken to demonstrate that the engineer responsible for it was ill informed and unreliable.

New York City has a line of motor omnibuses running on Fifth Ave. and on certain streets in the upper part of the city. The fares charged on these vehicles are double those charged on the street cars, but it is doubtful, when all the items of depreciation and maintenance are included, if the profits of the omnibus per mile run are as great as those of the street car.

In every city save one of the civilized world, the electric street car has been accepted as the main agency for passenger transportation. It is supplemented, of course, in the larger cities by electric cars running on elevated structures or in underground subways, while a small fraction of the wealthier classes of the community travel in cabs. In the largest city of the world, however, this situation is reversed in a remarkable way. A very large proportion of the passenger traffic in London streets is still carried in omnibuses and nearly all of these are now propelled by motors instead of by horses. At the present time our English engineering contemporaries are attacking in a most surprising manner the street railways of London and are declaring that the motor-bus and not the street car is the vehicle of the future.

It is of interest to inquire why London should be an exception to all other cities of the world in its solution of the street-traffic problem. To go into history a little, it is a fact that English cities generally were far behind the cities of other countries in the adoption of electricity on street railways. The opposition to overhead trolley wires was chiefly responsible for this, but the vested rights of the omnibus companies who controlled a large part of the street passenger traffic was also an undoubted influence. It may be remarked in passing that the horse-drawn street car was never as extensively used in English cities as it was in American. In nearly all American cities, street omnibuses had become obsolete by the time the electric car appeared on the horizon. In English cities, however, this was not at all the case. To this day large numbers of horse-drawn omnibuses are running regularly in a large proportion of British cities. In the central parts of London, up to a dozen years ago, the entire passenger street traffic was moved by omnibuses and cabs; and the density of passenger-vehicle movement on the principal London thoroughfares far exceeds that on any other streets in the world.

Of course, these horse-drawn buses and cabs have small passenger capacity compared with electric street cars and their speeds are comparatively low. This system of passenger transport, therefore, would have broken down a dozen years ago from sheer inability of the streets to accommodate the volume of traffic had it not been for the development of the network of subway lines.

London has now, as most of our readers know, an elaborate network of "tube railways," as they are called, which, by the way, furnish an admirable illustration of the inherent defects in the British economic system of reliance upon private enterprise for public work. Practically all the tube railways were originally planned as independent lines, which originally competed with each other for traffic to a greater or less extent. These tube railways are now operated as one system with an elaborate arrangement of transfers; but a make-shift system of junctions has been necessary and the whole system is a very complicated labyrinth for anyone but a native to find his way about in. While this underground subway system is far from ideal in its layout to cover the territory which needs rapid-transit accommodations, it has provided for the natural increment of traffic, leaving the surface of the streets still crowded with a dense mass of moving vehicles which is a constant source of amazement to the American newly arrived in London.

While the street omnibuses of London are run by private companies, the street-railway lines or trams, as they are there known, are a municipal enterprise, being built and operated by the London County Council. The body, appreciating the pressure of traffic upon street capacity and the necessity of making better provision for transit between the center of

the city and its suburbs, has been active during the past dozen years in the construction of street-railway lines, operated chiefly on the electric conduit system. With all due respect to the prejudices of our esteemed English contemporaries, we seem to discern in the fact that these street railways are a municipal enterprise, one of the reasons, conscious or unconscious, why they are anathema there.

It is nothing less than amazing to an American, accustomed to the electric street-car service of an American city, to read the tirades in some of our English exchanges against the London County Council tramways. We quote, for example, the following from the *Contract Journal* of Oct. 2:

> Gradually the size and weight of tramcars have been increased and the lines extended at great cost and inconvenience to everybody except the few to whom a charity ride is acceptable on any terms.
>
> The speculative builder has built and built houses and cottages connected by tramrails to London, and for a time has emptied thousands of houses in every part of London within a couple of miles of Charing Cross or London Bridge—houses which only want clearing out and cleaning up to be as good and as convenient for the masses and as desirable for them as the small houses in Mayfair are to the better-off classes, and for the same reason—namely, accessibility.
>
> These empty houses are paying no rates, or only empty house rates, and the workpeople are being taken in drafty, glass-house, upper-deck smoking compartments of tramcars an hour's ride to gardens they do not want, and doing an hour's ride back again in the morning. Many are growing tired of the waste of time. Many more are tired of the dangers attending the crossing the road space (often in the mud) between pavement and tramcar, and between car and pavement, and of the occasional stoppage of a half-mile of tramcars because of something wrong on the line or in one of the cars.

It is interesting, as one reads the above abstract, to recall how many American street-railway magnates have posed as philanthropists because the construction of their lines has enabled thousands and hundreds of thousands of wage workers to find homes in the suburbs instead of living in densely crowded tenements in the heart of the city. Our British contemporary, however, declares that the working people ought to have cleaned house and stayed where they were instead of spending their time riding back and forth in "drafty, glass house, upper-deck smoking compartments of tram cars."

Again the tramways are attacked because of the obstruction to street traffic by their rails. In American cities we have become accustomed to the presence of street-car rails in the pavement and appreciate that whatever slight obstruction they offer to other vehicles is more than offset by the extent to which they lessen the density of traffic by carrying passengers who would otherwise have to travel in wheeled vehicles over the pavement.

In London, however, with its whirling masses of buses and cabs, the presence of the rails in the street surface gives cause for bitter complaint. Our contemporary above quoted declares that the broken axles and wheels and other damage done to common road vehicles in Greater London by the car tracks probably does not amount to less than £1000 a day—an estimate which to us, we must confess, seems so extravagant as to be unbelievable.

Our contemporary admits that possibly there may have been good reasons for building tramways fifteen or twenty years ago, but declares that by reason of the development of the motorbus during the past half-dozen years the electric street car has become obsolete and no more street railways should be built.

There appears to be this much justification for the criticisms of the London tramway lines: These lines are not at present a financial success. Notwithstanding the density of London's passenger traffic, the County Council's tramway managers seem to have difficulty in filling their cars. Of course, there is no attempt on these municipally owned lines to increase profit by hanging the passengers from straps after the customary fashion of American street-railway managers; but the street railways in other European cities pay handsomely with seats for all passengers; and it is difficult to see why the London tramways should not be equally profitable.

Doubtless one reason why the motorbuses are crowded while the street cars are not, may be found in the fixed habits of Londoners and their strong prejudices. The omnibus is patronized by all classes of people, at least below "the Upper Ten," without a thought of loss of social caste; but we suspect the tram-cars are considered to be a "working-class" conveyance. Again the superior speed of the tram-cars does not count in the competition with the bus lines as it would in the United States. The average rider on top of a London bus is in no hurry to reach his destination and sits and smokes with the utmost calmness if the vehicle is stopped by a street jam, as happens every few blocks, where an American would be frothing with impatience. Again the bus has the advantage over the tramcar that it draws up alongside of the curb to take on or discharge passengers, while to take a car one must venture out into the stream of rapidly moving vehicles, over a more or less greasy pavement.

These are among the probable reasons why a large proportion of the street traffic of London still continues to patronize the motor buses instead of tram-cars. The question of greatest engineering interest, however, relates to the relative cost of the service. The fares on the two classes of vehicles are, we believe, substantially the same and are considerably lower than the fares charged for short-distance rides on American street railways.

According to a statement in *The Engineer*, which it begins with the cautious introduction "it is reported," London motor omnibuses cost 6¾d. (13½c.) per mile to run, including maintenance, depreciation and administration, while their average earnings are about 11c. per mile. The cost of operating the London County Council tram-cars is stated to be 11d. (22c.) per mile, and *The Engineer* quotes estimates "by competent authorities that the shortage on the London County Council tramways for the year ending Mar. 31 next will be about £80,000." It admits, however, that this shortage is partially due to the fact that the tramways are taxed £100,000 a year for maintenance of the street paving between and adjoining their tracks and that they have to pay their share of various local taxes in the London boroughs.

Whether these figures are accurate for London conditions we cannot say, but they fail to correspond at all with American experience. That a London motorbus can be run at a total cost of 13½c. per mile, including the wages of the motorman and conductor, expenses for gasoline, tires and repairs, remembering that gasoline is subject to a heavy tax and that its cost is much higher than in the United States, seems so miraculous as to be unbelievable. The companies operating motor cabs in American cities have had to raise their rates far above those originally established on account of the heavy expenses of maintenance and repairs. Very few American owners of motor cars can show a lower total running cost than 12 to 13c. per mile, even where they run their cars themselves. Official figures recently laid before us showing the cost of running an ordinary gasoline touring car owned by one of the departments of New York City amounted to about 50c. per mile for an annual mileage of some 5000 miles. We could quote many other instances as to actual costs of the operation of motor vehicles of ordinary size which would go to show the impossibility of running a motor vehicle large enough and heavy enough to carry 50 or more passengers and requiring two men for its operation at any such low cost as 13c. per mile run.

On the other hand, the figure of 22c. per mile as the cost of operation of electric street cars seems astonishingly high, especially when one considers the comparatively low wages paid to conductors and motormen in England, to say nothing of wages in the repair shops. The average total operating cost of American elec-

tric street cars of fair size is probably 15 to 18c. per mile, higher figures being reached, of course, on heavy interurban cars.

We are strongly inclined to the opinion, therefore, that on the purely economic side of the question, the motor omnibus running on the pavement cannot possibly compete in operating cost with the electric street car running on rails as a means of street passenger traffic, either in London or in any other city.*

Besides all this, the comparison made by our contemporary does not take into account at all the wear and tear on the street pavement produced by the heavy motorbus. In order to make the comparison a complete one, therefore, all the expense of maintaining the street-car tracks should be deducted from the car-mile expenses of the tramway.

We have no doubt that the London omnibus will continue to hold its own in the competition, over a considerable part of London's area at any rate, even if it has to make some increase in its fares in order to make both ends meet. We hope so at any rate, for the sake of every American engineer who visits London and who is wise enough to see its sights in a democratic way from the top of a bus rather than through the windows of a motor cab. On the other hand, we have little fear that even in London the electric street car is to be relegated to the museum as an obsolete contrivance. The economy of a vehicle running on rails can never be equalled by that of a vehicle running on the street surface.

*What appear to be more accurate figures as to the cost of street railway operation in England are contained in the following quotation from the London Times Engineering Supplement of Oct. 16:

"A keen discussion has been in progress in Birmingham regarding the relative merits of tramways and motor-omnibuses. Early in the year the City Council instructed the Tramways Committee to proceed with the construction of a tramway along the Hagley-road, but subsequently a resolution was carried authorizing the Tramways Committee to report on the advisability of obtaining Parliamentary powers to run a service of motor-omnibuses, and to defer the construction of the tramway.

Information obtained by the committee regarding the relative costs of operating and maintaining the two systems shows that the cost of working the tramways in Birmingham is 6.906d. (14c.) a mile, while that for the motor-omnibuses would be 8d. (16c.) a mile. They also considered reports from other corporations who have experimented with motor-omnibuses, and have come to the conclusion that from the points of view of economy and trustworthiness, those vehicles do not at present compare favourably with electric tramcars. They are unable therefore to recommend a motor-omnibus service in any of the districts in which tramway extensions are contemplated, but unanimously consider that the council should definitely authorize the construction of all the tramways referred to in the new Act.

The committee also considered the question of the railless trolley system for Harborne, but, apart from the difficulties of installation, they think it would be impossible for it to cope with the traffic and they cannot recommend its adoption."

It should be pointed out that while the figures given in the above quotation for tramway costs are taken from the city's own tramways, the figures for motor omnibus operation were obtained elsewhere. We are therefore skeptical as to whether all the items of expense in motor omnibus operation have been included in making up these figures.

Annual Meeting of the Association of Railway Electrical Engineers

The fifth annual convention was held at Chicago, Oct. 21 to 25, the meeting place and exhibition hall being at the Auditorium Hotel. There were seven business sessions, and the entertainments included the usual annual dinner. The officers elected include the following: President, D. J. Cartwright, Electrical Engineer, Lehigh Valley R.R.; Secretary and Treasurer, Joseph A. Andreucetti, General Foreman, C. & N. W. Ry., Chicago. The next annual meeting will be held at Chicago, but the semi-annual meeting will be at Atlantic City, N. J., in June.

The proceedings related mainly to train lighting and shop equipment, but included also a paper on electric traction. The report of the Committee on Train Lighting Practice dealt with the maintenance of train equipment and the organization for this work. The report of the Committee on Data and Information presented statistics as to electrically lighted cars and as to the power requirements of electrically operated shop tools. The report of the Committee on Improvements described improved appliances for car lighting, shop equipment and electric supplies generally, this information being furnished by a large number of manufacturers. The Committee on Standards submitted a comparison of recommendations of this association and the M. C. B. Association (train-lighting committee); a sub-committee also discussed the question of standardizing ball bearings for axle-generators on cars. The Committee on Specifications submitted specifications as follows: canvas belting for driving axle-generators, incandescent lamps, and wire for potentials up to 750 volts (as used for car and general lighting, shop machinery and general distribution from low-tension power buses).

Three papers were presented in addition to the seven committee reports. A paper on "The Application of Steam Turbines to Railway Shop Work," by W. J. A. London and A. P. Peck, was read by the latter; it dealt with the single-stage or impulse type of turbine and was illustrated by views showing its application to the driving of generators, pumps, line shafting, etc. A paper on "Industrial Lighting," by B. F. Fisher, Jr., discussed the fundamental principles involved in proper and economical lighting, rather than the details of equipment. In his opening remarks, the author pointed out that while ventilation and sanitation have been made the subject of laws in regard to industrial establishments, he knew of no law relating to the provision of efficient lighting. The third paper, by N. W. Storer, was on "Electric Traction." It dealt with the electrification of steam railways, and was illustrated by numerous views of large electric locomotives.

Car Lighting by Electricity

The Committee on Train Lighting Practice reported that the extensive changing of head-end systems from 110 volts to 60 volts has resulted in realizing the advantages expected, while the association's recommendation of uniform voltage has been generally accepted. There was a general discussion also on the special conditions of lighting mail cars.

Statistics—The figures presented by the Committee on Information are summarized in the accompanying table, and we have added the figures for the previous year for purposes of comparison. They represent 57 railways and the Pullman company. In the straight-storage system, 60 or 64 volts were used on about 1560 cars, 30 or 32 volts in 90 cars, and 110 volts in only 11 cars. Of the head-end system, 553 cars used 110 volts and practically all the others 64 volts. Of the axle-system, nearly 90% used 30 or 32 volts, and the others 60 or 64 volts.

TABLE OF ELECTRICALLY-LIGHTED CARS ON STEAM RAILWAYS

	1912	1911
Lighted by electricity	13,736	11,000
Lighted by other means	29,075	.....
Straight storage-battery system.	1,673	1,372
Turbine system (includ. 48 locos)	481	
Head-end system	2,073	3,185
Axle-generator system	7,160	5,900
Owned and op. by railways	7,749	.....
Owned and op. by Pullman Co.	1,310	.....
Total cells of battery	234,069	202,744
Cars contracted for	1,324	.....

Light Failures—A failure is charged against the cars when they arrive at a terminal with less than 25 volts (35-volt tungsten lamps being used). For an average of 120 cars per month the reports were as follows:

	No. of Failures	Miles per Failure
Jan	14	88,900
Feb	6	199,000
March	13	101,000
April	11	107,000
May	7	187,000
June	2	661,000

Driving Belts—For axle-generator systems, the belt renewals on 120 cars per month ranged from 48 in January to 11 in August, with an average mileage per belt of 25,952 in the former case and 116,000 in the latter. The Committee on Train Lighting recommended trials of belt-fastening devices of the hinge type, as breakage at clamp fastenings is a large cause of belt losses.

MAINTENANCE WORK—The above committee stated that it is not possible to have a uniform organization as conditions vary on different roads. One road with over 400 cars has about 20 cars per day, while another road with fewer cars has 40 or 50 cars per day at its largest terminals. The time at which trains arrive and leave also has its effect on an organization. It is considered, however, that two men can handle 15 cars per day (10 hr.) exclusive of batteries and shop work, handling only regulators and dynamos. In the discussion this was thought to be too high, and one member has made extended inquiries on the basis of which he estimated 1 man per 10 cars for both shop and road work.

With the head-end system it is universal practice to teach baggage men to operate train-lighting sets. They handle all connectors and stock on the trip and clean up their equipment before arriving at end of run, leaving a complete report of the condition of their train, and generating sets, oil and supplies for train. Inspections of condition of trains are made by yard men. The B. & O. R.R. employs train electricians who do nothing but electrical work. With the axle-generator system, it is necessary to have men devoting all or part of their time to inspecting various features of car-lighting equipment.

ELECTRIC WIRING FOR BUILDINGS

The Committee on Installation of Wiring for Electric Light and Power in Railway Buildings presented recommendations as to various classes of structures, and pointed out that the permanent value of the work often depends more upon the workmanship than the materials. Consequently, great care should be taken in the installation of electric wiring, and the Underwriters' Code should be followed as closely as possible. In general, exposed overhead conduits are preferred, although underground conduits may be used for machine shops (power wiring only), and either underground or overhead conduits for ashpits. For the power wiring of machine shops, the report recommended a separate circuit direct from the panel box to each tool, but some members preferred branches from the main conduit lines, this being cheaper than the panel-box system. The committee pointed out that it is much more difficult to locate troubles when no panel box is used, and that in large shops the wiring may be subdivided into sections, each with its own panel-box. As to the relative merits of drop-lights and fixed lamp receptacles at individual tools, the committee recommended the latter, and this view was generally supported. One member advocated general lighting without individual lights. The answer to this was was that in many cases the latter are indispensable to insure good work. Further, if a man considered he needed more light and did not get it, and then sustained some injury, a damage claim might be strongly supported by evidence as to lack of proper light. The report led to a lengthy discussion which showed a variety of individual practice and opinion.

ELECTRIC EQUIPMENT OF RAILWAY SHOPS

The report of the Committee on Shop Practice dealt in a general way with the equipment for light and power, and was largely identical with a paper on the same subject read at the September meeting of the Western Railway Club (Chicago). As to whether direct or alternating current should be used, it was stated that there is a diversity of opinion, but that in a majority of cases a combination of both systems is preferred. Recent developments in A.C. motors for driving machine tools through speed-change gears and by speed control have brought them to nearly the same degree of flexibility as D.C. motors. Either A.C. or D.C. distribution can be made safely at 440 volts, and this is high enough for any existing railway shop. The distribution of power to the shops may be by overhead or underground lines, but the present tendency is to put all steam, air and water pipes and electric cables in tunnels. This makes inspection easy, and results in fewer cases of trouble. However, instead of placing the cables in the tunnel it is better to put them in ducts alongside of the tunnel, so that they will not be affected by the heat of the steam pipes. As to the power plant, steam turbines are being used extensively, although many engineers favor reciprocating engines for driving D.C. generators. One point in favor of the former is the use of the exhaust steam for heating the shops, but a recent type of steam turbine has been designed specially with a view to its use in connection with shop-heating systems.

The report dealt also with the various types of motors adapted for driving different classes of machinery, and suggested a more extensive use of storage batteries (for such special purposes as emergency lighting, and the operation of red lights at fire-hose stations), and of elec rically operated safety devices, machine stops, fire alarms, etc. As to lighting, the report advocated for large shops a combination of flaming-arc lamps for general illumination, tungsten clusters for group lighting, and drop lights for machines when required. In the discussion, however, fixed lights on the machines were considered preferable to drop light, as noted above in regard to the wiring of buildings. The committee considers that the individual lighting of machine tools is very important. The flaming-arc lamp is suitable for large areas in locomotive and blacksmith shops, foundries and yards because of its high power and great penetrating property. Mercury-vapor lamps are used to some extent in medium sized shops. Carbon-filament lamps are preferred for drop lights on account of their ability to stand rough handling, but the new tungsten lamp with drawn-wire filament are being used to some extent. The paper on "Industrial Lighting" noted above, related largely to the conditions of railway shop work.

The Specific Heat of Wood has recently been determined for a number of different specimens of 20 of the more important varieties by the U. S. Forest Service. The results of these studies are embodied in Bulletin 110 of the Forest Products Laboratory Series, written by Frederick Dunlap.

From this publication it appears that the mean value for the interval 106°-0°C. was nearly the same for all specimens and all species of oven-dried wood. This average is 0.327, a figure to be compared with the older values 0.467 to 0.650 (Kent's Pocketbook.)

The variation of specific heat with temperature was also studied and reported to be (above 0°C.) according to the expression $c=0.266+0.00116\,t$.

Exposure to moisture at high temperature (steaming) gave greatly increased specific heats, but these are not definitely reported on in this publication as further study is planned.

A New Water Supply System for Akron, Ohio, was described by Mr. H. H. Frost, Superintendent of the Akron Waterworks, at the recent meeting of the Central States Waterworks Association. The City of Akron has purchased the property of the Akron Waterworks Co., and took possession of the same on April 1 last. The supply furnished by the company was inadequate in both quantity and quality. Under the direction of Messrs. F. A. Barbour, of Boston, and E. G. Bradbury, of Columbus, O., a new supply is to be introduced in Akron from the Cuyahoga River.

A dam will be built across the river near the village of Kent, about nine miles from Akron, which will create a storage reservoir large enough to supply the city through a long period of drought. The dam will probably be of the hollow reinforced-concrete type. Water from the reservoir will be carried through a 60-in. reinforced-concrete conduit a distance of about half a mile to the purification works and pumping station. At this point the water will be treated with coagulants, passed through rapid sand filters, sterilized with hypochlorite of lime and discharged to a clear water reservoir. From this reservoir two 15,000,000 gal. high duty vertical triple expansion pumping engines will deliver the water into a 36-in. force main of steel lock bar construction 10 miles in length. This main will deliver the water to a 20,000,000 gal. distributing reservoir in the eastern part of Akron. The total estimated cost of the work is $1,650,000, of which $450,000 is the cost of land and water rights. In addition to this, about $750,000 is to be expended in the building of the distributing reservoir and the reconstruction and extension of the distributing mains in the city. Special attention is to be given to furnishing adequate fire protection by increasing the size of the mains and increasing by 50% the number of fire hydrants.

Controlling the Mississippi River

By Col. C. McD. Townsend †

Wide publicity has been given to the proposal to control the floods of the lower Mississippi by building reservoirs on its headwaters and by reforestation of its drainage basin. At the Interstate Levee Convention held at Memphis the last week in September, the paper of greatest engineering interest was read by Col. Townsend, President of the Mississippi River Commission, presenting in detail the reasons why the levee system of river regulation has been found superior to all other proposed plans in all countries of the world. It is important that the engineering profession at large should have sound opinions on this subject. Col. Townsend's paper furnishes a foundation for such opinions.

*From a paper read at the Interstate Levee Congress at Memphis, Tenn.

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When such a disaster occurs as has swept over the Mississippi valley within the last few months, it arouses the intellectual activity of our people, and many suggestions are made of the means of preventing it.

As president of the Mississippi River Commission I have received numerous communications, attempting to explain the causes of this great flood, or giving the writer's views of the mistakes which have been made by the Mississippi River Commission in handling it.

The Mississippi River Commission has explained with great detail in its reports its reasons for relying on levees for protecting the country from overflow, but they appear to be unknown, not only to the country at large, but to many who reside in the Mississippi valley and are most vitally interested in the problem.

I therefore consider it proper to appear before you and accept the invitation of the illustrious speaker who preceded me [Ex-President Roosevelt] and state briefly reasons for rejecting the various methods of flood control, other than levees, which have been suggested. As a full discussion of any one of the propositions would prolong my remarks to such an extent as to tax your patience, I can only touch upon the subject, and I have confined myself to stating not what I consider the most logical argument for the engineer, but the reason most evident to the general public for rejecting a proposition.

Forests and Floods

Judging from my correspondence, it would appear that there exists in the public mind an impression that the prime cause of floods in this country has been the destruction of the forests, and that the surest way to prevent them is by reforestation.

The subject of the influence of forests on stream flow is not unknown to the river engineer. It has been extensively discussed both by European and American engineers since Gustav Wex, imperial and ministerial counsellor and engineer of the improvement of the Danube River at Vienna, in 1872, submitted a series of papers on the decrease of water in springs, creeks and rivers, which were translated into English by the late Gen. Weitzel of the corps of engineers.

There is a great diversity of opinion on the subject, some maintaining that the cutting off of forests will ultimately convert Europe into a Numidian desert, while others claim that a moderate cutting of the forests even increases the rainfall. Whatever may be the theoretical principles involved, their practical application to the lower Mississippi River is fraught with great difficulty.

When a country acquires a population of nearly 100,000,000 people the forest primeval which existed when it was first settled has to disappear. It is all very well to bemoan the fact that if the black walnut, which once covered the State of Ohio had not been destroyed, and was sold as lumber at the present market rates, it would equal the assessed valuation of the property of the state; but there now have been created the cities of Cleveland and Cincinnati, whose people cannot live on black walnuts alone, but require grain and meat. The black walnut of Ohio has gone, never to return, and it is the same in other sections.

The fertile lands will not be taken away from the farmer. They are too valuable for raising potatoes and hogs. Only the poorer soils can be used for forest culture, and only a limited reforestation then is possible. It is, therefore, ridiculous to expect any better results in reference to floods from reforestation than existed before the forests were destroyed.

While our official gage records do not, in general, extend back much more than 40 years, yet on several of the Western rivers we have records of the heights of floods extending over a century. Thus at St. Louis there is a flood recorded in 1844, having a height of 41 ft. on the gage. The next highest flood, in 1785, was over 40 ft. At Cincinnati, in 1832, there was one of 64 ft. It is needless to explain to this audience that a flood of such heights in either the Ohio or upper Mississippi would mean ruin to the plantations below Cairo if there were no levees to protect them.

It is, however, argued by some that with reforestation, if the floods occasionally were high they would not be as frequent. Again let us search the records of the past. It is hopeless by reforestation to expect to reproduce the forest growth that existed at the close of the Civil War. Yet from 1857 to 1867 was a most remarkable series of great floods, occurring as frequently as any that have been recorded since that time.

Reservoirs for River Control

Next to reforestation, reservoirs as a means of controlling floods appear to have the most advocates. The reservoir theory is particularly attractive, as we have before us in the great lakes a practical illustration of flood restraint, by means of natural reservoirs. Reservoir control of the Mississippi River was discussed by Humphrey and Abbot in 1858, and on the upper Mississippi the corps of engineers has constructed the largest system of reservoirs for regulating rivers that has been built in any country, having nearly twice the capacity of those proposed by the Pittsburgh flood commission for controlling floods at Pittsburgh. These reservoirs have been most successful, not only for increasing the low water discharge of the Mississippi River above St. Paul, the purpose for which they were constructed, but also for reducing floods in that portion of the river.

There is, therefore, nothing novel to the river engineer in the proposition to control rivers by reservoirs. We have not only studied its advantages, but we know its limitations. Conditions are extremely favorable for reservoir construction at the headwaters of the Mississippi, but while they materially increase the low water discharge at St. Paul and markedly reduce flood heights, yet 100 miles further down the river it is impossible to detect their influence during either high or low water.

A reservoir must be close to the locality to be benefited, or its value rapidly diminishes, and this is a serious trouble with any project for regulating the lower Mississippi by reservoirs.

The material which is eroded from our hills is carried down by our rivers and deposited during floods on the lowlands of the lower reaches, making them the richest agricultural portions of our country. They become highly cultivated, buildings and fences are constructed, towns spring up and are connected by highways and railroads. Railroad wrecking is a rather popular amusement at present, so I omit their relocation from the discussion, but the engineer had better beware of that horny-handed son of toil, the American farmer. He is not going to consent to be driven from the

rich alluvial valley to the less fertile hills, and is going to protest most vigorously against structures which will cover his fields with water from 150 to 200 ft. deep. As he has votes, it is going to be necessary to listen to him, and the dams must be moved back to mountain streams where land is of little value. This renders necessary the construction of the reservoirs to control the Ohio River on the upper branches of the Allegheny, Monongahela and other tributaries, over 1000 miles from its mouth. Those on the upper Mississippi will also be about 1000 miles from Cairo, and those on the Missouri over 2000. These are too great distances for the proper regulation of any stream.

Moreover, such a project leaves too large a proportion of the watershed unprotected to be effective. In fact, the flood of 1912 was caused by rains in that portion of the valley which would be without reservoirs. It was not the melting snow at the sources, but rains in midstream areas that created the damage. Neither at Cincinnati, St. Louis, Chattanooga or Nashville were flood heights excessive.

The Pittsburgh Flood Prevention Plan

I have recently been appointed a member of a board to investigate the use of reservoirs to protect the city of Pittsburgh from overflow. The Pittsburgh Flood Commission has a carefully prepared project which proposes to store in 17 reservoirs 59,000,000,000 cu.ft. of water at an estimated cost of about $21,000,000, which I consider very reasonable. Fifty-nine thousand million is a pretty large looking figure, but I made a little computation to see what it meant when translated into a unit applicable to the Mississippi River, and found that during less than seven hours 59,000,000,000 cu.ft. of water flowed by the latitude of Red River at the crest of the recent flood, and, based on the estimate of the flood commission, it would, therefore, require over $73,000,000 to build reservoirs that would hold the water that passed down the river in one day. The cost of storing one day's flow is ample for all the levee construction required on the river, while if reliance is placed on reservoirs, provision must also be made for the other 48 days the river was above a bank-full stage.

The "Cutoff" Plan for Reducing Flood Heights

Another favorite method suggested for reducing flood heights is by means of cutoffs. The Mississippi River Commission in numerous reports has called attention to the injury which would result from cutoffs, the increased caving which is caused thereby, and the damage to navigation during low water.

These may be thought by some theoretical considerations. I desire to invite attention to the fact that cutoffs have been repeatedly tried in Europe as a means of reducing floods, but always with disastrous results. The most noted example is the river Theiss in Hungary.

This river originally had a very gentle slope, about equal to that of the Illinois River below La Salle. It was leveed with the same results which always obtain when rivers are confined—the height of its floods increased. It was then proposed to shorten the river by cutting off the bends, and thus giving it a deeper slope. The project was carried out, but the first great flood that occurred after the work was completed, rushed through the improved section much faster than the lower part of the river could carry it off. Flood heights were lowered, to be sure, at the upper end, but correspondingly increased at the lower, and in 1879 the town of Szegedin was destroyed by the flood.

At the Canal de Miribel on the Rhine a similar method was tried, with similar results. At the upper end of the reach both the high-water and low-water planes were lowered, with great damage to the low-water navigation, while at the lower end they were raised, producing increased flood heights and also injury to the low-water channel. A cutoff affords relief at one locality, but at the expense of another.

Opening Additional Outlets

Outlets have been suggested as another means of relief, and the Mississippi River Commission has frequently discussed the inadvisability of outlets and waste weirs as a means of lowering flood heights. I differ with some of my conferees on this subject, but rather in the line of argument than in results. Where the river has depths exceeding 100 ft., as in the vicinity of New Orleans, I am of the opinion we could afford to permit a moderate diminution of river depths if thereby we could obtain a material reduction of levee heights. I also believe that the effect of outlets in reducing flood heights is not as great as is popularly supposed. The last flood, however, clearly demonstrated that wherever there was a large crevasse, which is but another name for an outlet, the river ceased to rise. Such outlets were not entirely satisfactory to the planter whose land was behind them. And another lesson to be derived from this flood is that if you are going to reduce flood heights by this means, you must also control your outlet, i.e., it will require a levee system of the same height as that of the main river, and the amount that is saved in the height of the levee line will not compensate for the extra length it is necessary to construct and maintain.

Another serious objection to an outlet is the difficulty in regulating the velocity with which the water will flow through it at varying heights of the main stream. If it is so constructed that it will discharge at a greater velocity than the river itself, there is danger of its enlargement to such an extent as to divert the greater part of the flow down it, and transfer the main stream itself into an outlet, and if, on the other hand, it discharges at a lower velocity, it will tend to fill with sediment.

Do Levees Raise the Level of the River Bed?

There is considerable confusion in the public mind in reference to the effect of levees on the river bed, some believing that they cause the bed to scour out, while others are equally as positive that they cause the river bed to rise.

The motion of sediment in a silt-bearing stream is not clearly understood, even by many engineers who write on river hydraulics.

In such a stream there are certain sections called pools, which are usually found in the bends. These are separated by shallower sections which are called bars.

When the river is low the velocity with which the water flows through the pools is less than that with which it flows over the bars, and there is a tendency for the channel over the bars to scour out and the material eroded to be deposited in the pool below. As a river rises the velocity in the pools increases more rapidly than on the bars, and a period soon occurs when there is a greater scour in the pools than on the bars, so that the bars begin to rise and the pools to deepen. When the river falls the velocities in the pools decrease more rapidly than on the bars, and there is a reversal of the process—the bars deepening and the pools filling up. This action is modified by a movement of sand waves down the river, and by a centrifugal force which results from the piling up of water in the bends, but it occurs in all alluvial streams which flow with sufficient velocity to scour their beds, whether they are leveed or not. Levees may, to a certain extent, intensify this action, but they will not materially change it.

With such constant mutations the only way to determine whether the river bed is rising or being scoured out is by comparing corresponding low waters with each other, or corresponding high waters.

Several hundred years ago a French traveler visited Italy, and on his return reported that levees had raised the bed of the Po River. His statement was carefully investigated and found to be untrue, but like Wex's assertion that the cutting of forests has injured river beds, it has traveled over the whole world where rivers have been improved, and vexed the engineer in charge of their improvement.

The French engineers have made careful investigations of the leveed rivers of France, and found no evidence of such

Controlling the Mississippi River

By Col. C. McD. Townsend †

Wide publicity has been given to the proposal to control the floods of the lower Mississippi by building reservoirs on its headwaters and by reforestation of its drainage basin. At the Interstate Levee Convention held at Memphis the last week in September, the paper of greatest engineering interest was read by Col. Townsend, President of the Mississippi River Commission, presenting in detail the reasons why the levee system of river regulation has been found superior to all other proposed plans in all countries of the world. It is important that the engineering profession at large should have sound opinions on this subject. Col. Townsend's paper furnishes a foundation for such opinions.

*From a paper read at the Interstate Levee Congress at Memphis, Tenn.

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When such a disaster occurs as has swept over the Mississippi valley within the last few months, it arouses the intellectual activity of our people, and many suggestions are made of the means of preventing it.

As president of the Mississippi River Commission I have received numerous communications, attempting to explain the causes of this great flood, or giving the writer's views of the mistakes which have been made by the Mississippi River Commission in handling it.

The Mississippi River Commission has explained with great detail in its reports its reasons for relying on levees for protecting the country from overflow, but they appear to be unknown, not only to the country at large, but to many who reside in the Mississippi valley and are most vitally interested in the problem.

I therefore consider it proper to appear before you and accept the invitation of the illustrious speaker who preceded me [Ex-President Roosevelt] and state briefly reasons for rejecting the various methods of flood control, other than levees, which have been suggested. As a full discussion of any one of the propositions would prolong my remarks to such an extent as to tax your patience, I can only touch upon the subject, and I have confined myself to stating not what I consider the most logical argument for the engineer, but the reason most evident to the general public for rejecting a proposition.

Forests and Floods

Judging from my correspondence, it would appear that there exists in the public mind an impression that the prime cause of floods in this country has been the destruction of the forests, and that the surest way to prevent them is by reforestation.

The subject of the influence of forests on stream flow is not unknown to the river engineer. It has been extensively discussed both by European and American engineers since Gustav Wex, imperial and ministerial counsellor and engineer of the improvement of the Danube River at Vienna, in 1872, submitted a series of papers on the decrease of water in springs, creeks and rivers, which were translated into English by the late Gen. Weitzel of the corps of engineers.

There is a great diversity of opinion on the subject, some maintaining that the cutting off of forests will ultimately convert Europe into a Numidian desert, while others claim that a moderate cutting of the forests even increases the rainfall. Whatever may be the theoretical principles involved, their practical application to the lower Mississippi River is fraught with great difficulty.

When a country acquires a population of nearly 100,000,000 people the forest primeval which existed when it was first settled has to disappear. It is all very well to bemoan the fact that if the black walnut, which once covered the State of Ohio had not been destroyed, and was sold as lumber at the present market rates, it would equal the assessed valuation of the property of the state; but there now have been created the cities of Cleveland and Cincinnati, whose people cannot live on black walnuts alone, but require grain and meat. The black walnut of Ohio has gone, never to return, and it is the same in other sections.

The fertile lands will not be taken away from the farmer. They are too valuable for raising potatoes and hogs. Only the poorer soils can be used for forest culture, and only a limited reforestation then is possible. It is, therefore, ridiculous to expect any better results in reference to floods from reforestation than existed before the forests were destroyed.

While our official gage records do not, in general, extend back much more than 40 years, yet on several of the Western rivers we have records of the heights of floods extending over a century. Thus at St. Louis there is a flood recorded in 1844, having a height of 41 ft. on the gage. The next highest flood, in 1785, was over 40 ft. At Cincinnati, in 1832, there was one of 64 ft. It is needless to explain to this audience that a flood of such heights in either the Ohio or upper Mississippi would mean ruin to the plantations below Cairo if there were no levees to protect them.

It is, however, argued by some that with reforestation, if the floods occasionally were high they would not be as frequent. Again let us search the records of the past. It is hopeless by reforestation to expect to reproduce the forest growth that existed at the close of the Civil War. Yet from 1857 to 1867 was a most remarkable series of great floods, occurring as frequently as any that have been recorded since that time.

Reservoirs for River Control

Next to reforestation, reservoirs as a means of controlling floods appear to have the most advocates. The reservoir theory is particularly attractive, as we have before us in the great lakes a practical illustration of flood restraint, by means of natural reservoirs. Reservoir control of the Mississippi River was discussed by Humphrey and Abbot in 1858, and on the upper Mississippi the corps of engineers has constructed the largest system of reservoirs for regulating rivers that has been built in any country, having nearly twice the capacity of those proposed by the Pittsburgh flood commission for controlling floods at Pittsburgh. These reservoirs have been most successful, not only for increasing the low water discharge of the Mississippi River above St. Paul, the purpose for which they were constructed, but also for reducing floods in that portion of the river.

There is, therefore, nothing novel to the river engineer in the proposition to control rivers by reservoirs. We have not only studied its advantages, but we know its limitations. Conditions are extremely favorable for reservoir construction at the headwaters of the Mississippi, but while they materially increase the low water discharge at St. Paul and markedly reduce flood heights, yet 100 miles further down the river it is impossible to detect their influence during either high or low water.

A reservoir must be close to the locality to be benefited, or its value rapidly diminishes, and this is a serious trouble with any project for regulating the lower Mississippi by reservoirs.

The material which is eroded from our hills is carried down by our rivers and deposited during floods on the lowlands of the lower reaches, making them the richest agricultural portions of our country. They become highly cultivated, buildings and fences are constructed, towns spring up and are connected by highways and railroads. Railroad wrecking is a rather popular amusement at present, so I omit their relocation from the discussion, but the engineer had better beware of that horny-handed son of toil, the American farmer. He is not going to consent to be driven from the

rich alluvial valley to the less fertile hills, and is going to protest most vigorously against structures which will cover his fields with water from 150 to 200 ft. deep. As he has votes, it is going to be necessary to listen to him, and the dams must be moved back to mountain streams where land is of little value. This renders necessary the construction of the reservoirs to control the Ohio River on the upper branches of the Allegheny, Monongahela and other tributaries, over 1000 miles from its mouth. Those on the upper Mississippi will also be about 1000 miles from Cairo, and those on the Missouri over 2000. These are too great distances for the proper regulation of any stream.

Moreover, such a project leaves too large a proportion of the watershed unprotected to be effective. In fact, the flood of 1912 was caused by rains in that portion of the valley which would be without reservoirs. It was not the melting snow at the sources, but rains in midstream areas that created the damage. Neither at Cincinnati, St. Louis, Chattanooga or Nashville were flood heights excessive.

The Pittsburgh Flood Prevention Plan

I have recently been appointed a member of a board to investigate the use of reservoirs to protect the city of Pittsburgh from overflow. The Pittsburgh Flood Commission has a carefully prepared project which proposes to store in 17 reservoirs 59,000,000,000 cu.ft. of water at an estimated cost of about $21,000,000, which I consider very reasonable. Fifty-nine thousand million is a pretty large looking figure, but I made a little computation to see what it meant when translated into a unit applicable to the Mississippi River, and found that during less than seven hours 59,000,000,000 cu.ft. of water flowed by the latitude of Red River at the crest of the recent flood, and, based on the estimate of the flood commission, it would, therefore, require over $73,000,000 to build reservoirs that would hold the water that passed down the river in one day. The cost of storing one day's flow is ample for all the levee construction required on the river, while if reliance is placed on reservoirs, provision must also be made for the other 48 days the river was above a bank-full stage.

The "Cutoff" Plan for Reducing Flood Heights

Another favorite method suggested for reducing flood heights is by means of cutoffs. The Mississippi River Commission in numerous reports has called attention to the injury which would result from cutoffs, the increased caving which is caused thereby, and the damage to navigation during low water.

These may be thought by some theoretical considerations. I desire to invite attention to the fact that cutoffs have been repeatedly tried in Europe as a means of reducing floods, but always with disastrous results. The most noted example is the river Theiss in Hungary.

This river originally had a very gentle slope, about equal to that of the Illinois River below La Salle. It was leveed with the same results which always obtain when rivers are confined—the height of its floods increased. It was then proposed to shorten the river by cutting off the bends, and thus giving it a deeper slope. The project was carried out, but the first great flood that occurred after the work was completed, rushed through the improved section much faster than the lower part of the river could carry it off. Flood heights were lowered, to be sure, at the upper end, but correspondingly increased at the lower, and in 1879 the town of Szegedin was destroyed by the flood.

At the Canal de Miribel on the Rhine a similar method was tried, with similar results. At the upper end of the reach both the high-water and low-water planes were lowered, with great damage to the low-water navigation, while at the lower end they were raised, producing increased flood heights and also injury to the low-water channel. A cutoff affords relief at one locality, but at the expense of another.

Opening Additional Outlets

Outlets have been suggested as another means of relief, and the Mississippi River Commission has frequently discussed the inadvisability of outlets and waste weirs as a means of lowering flood heights. I differ with some of my conferees on this subject, but rather in the line of argument than in results. Where the river has depths exceeding 100 ft., as in the vicinity of New Orleans, I am of the opinion we could afford to permit a moderate diminution of river depths if thereby we could obtain a material reduction of levee heights. I also believe that the effect of outlets in reducing flood heights is not as great as is popularly supposed. The last flood, however, clearly demonstrated that wherever there was a large crevasse, which is but another name for an outlet, the river ceased to rise. Such outlets were not entirely satisfactory to the planter whose land was behind them. And another lesson to be derived from this flood is that if you are going to reduce flood heights by this means, you must also control your outlet, i.e., it will require a levee system of the same height as that of the main river, and the amount that is saved in the height of the levee line will not compensate for the extra length it is necessary to construct and maintain.

Another serious objection to an outlet is the difficulty in regulating the velocity with which the water will flow through it at varying heights of the main stream. If it is so constructed that it will discharge at a greater velocity than the river itself, there is danger of its enlargement to such an extent as to divert the greater part of the flow down it, and transfer the main stream itself into an outlet, and if, on the other hand, it discharges at a lower velocity, it will tend to fill with sediment.

Do Levees Raise the Level of the River Bed?

There is considerable confusion in the public mind in reference to the effect of levees on the river bed, some believing that they cause the bed to scour out, while others are equally as positive that they cause the river bed to rise.

The motion of sediment in a silt-bearing stream is not clearly understood, even by many engineers who write on river hydraulics.

In such a stream there are certain sections called pools, which are usually found in the bends. These are separated by shallower sections which are called bars.

When the river is low the velocity with which the water flows through the pools is less than that with which it flows over the bars, and there is a tendency for the channel over the bars to scour out and the material eroded to be deposited in the pool below. As a river rises the velocity in the pools increases more rapidly than on the bars, and a period soon occurs when there is a greater scour in the pools than on the bars, so that the bars begin to rise and the pools to deepen. When the river falls the velocities in the pools decrease more rapidly than on the bars, and there is a reversal of the process—the bars deepening and the pools filling up. This action is modified by a movement of sand waves down the river, and by a centrifugal force which results from the piling up of water in the bends, but it occurs in all alluvial streams which flow with sufficient velocity to scour their beds, whether they are leveed or not. Levees may, to a certain extent, intensify this action, but they will not materially change it.

With such constant mutations the only way to determine whether the river bed is rising or being scoured out is by comparing corresponding low waters with each other, or corresponding high waters.

Several hundred years ago a French traveler visited Italy, and on his return reported that levees had raised the bed of the Po River. His statement was carefully investigated and found to be untrue, but like Wex's assertion that the cutting of forests has injured river beds, it has traveled over the whole world where rivers have been improved, and vexed the engineer in charge of their improvement.

The French engineers have made careful investigations of the leveed rivers of France, and found no evidence of such

action; the Germans have studied the Rhine, and the Austrians the rivers of Austro-Hungary, and failed to detect it. The Mississippi River Commission has made similar observations of the Mississippi River, and found more evidences of a scour than of a fill. In no case has it been observed that the effect of levees to raise the river bed was more than a few tenths of a foot in a hundred years, and may be termed a geological effect resulting from the lengthening of the river as it deposits its silt at its mouth.

The assertion is now admitted to be false on the main rivers of all civilized countries which are capable of being studied, but it is still claimed that it is true in China and Japan. I recently visited Japan and had an opportunity to further investigate the subject. On the larger rivers, like the Osaka, there were no evidences of any such action, but in mountain streams which flow down steep hillsides and suddenly change their slope when they pass through plains, as is the case with a number of streams which empty into Lake Biwa, the upper portions of the streams have been scoured out, forming deep gulleys, and the material thus eroded deposited at the foot of the hills. The same conditions exist on the mountain streams which empty into the Mississippi that are not leveed, but the eroded material has an opportunity to spread over a greater area at the foot of the hills and is, therefore, not as perceptible.

My own view of the effect of levees on stream flow is that they tend to remove irregularities and make the slope more uniform. If a cutoff should occur, disturbing the river's regimen, they would tend to cause the river to return more quickly to its normal slope, raising those bars which had been unduly lowered, and scouring out those which were abnormally high. They should also, to a certain extent, enlarge the river section, but at a rate so low that it would be a question of practical importance to those who will inhabit the valley in the 25th century, rather than those who are tilling it today.

The Necessary Height of Levees

While there is no evidence that the bed of the Mississippi River has risen from levee construction, it is apparent that flood heights have greatly increased in the last 20 years.

When the Mississippi River Commission was formed there existed two schools of engineers—one believed if the river were leveed it would scour out so that a large increase in flood heights would not occur, the other that there would be little enlargement of the river section, and that flood heights should be computed without regard thereto.

There was considerable discussion of those propositions, both by the commission and the general public, and the general public was very strongly opposed to the theory that high levees were necessary.

I take the liberty of recalling that about 20 years ago I submitted a paper to prove that if the St. Francis basin were leveed a flood like that of 1882 would attain a height at Helena of at least 54 ft. I was forthwith changed with being an enemy of the levee system. A state of the public mind existed similar to that which arose in Louisiana at the commencement of the recent flood, when I intimated there was danger to the levees of that state. I do not recall that any demands were made for my removal, but it was suggested to the commission that investigations by subordinate officers be discouraged.

Under these conditions it was necessary for the commission to establish a grade line for levee construction, and they announced a provisional grade, which was neither as low as many persons considered ample, nor as high as others thought necessary. This grade was generally accepted as a line to build to, the ultimate grade to which levees were to be constructed to be afterwards determined by observation.

This was a most happy solution of the problem, as was forcibly demonstrated during the last flood, during which less than 1% of the length of the levee line was destroyed. The engineer must always bear in mind that he must make the best use that is possible of the funds with which he is entrusted. If the ultimate grade line which this flood shows is necessary had been adopted, it is true that many miles of levee would have been held with comparatively little effort, as was the case in the upper Yazoo district, but to attain such a result the funds which would have been expended in construtcing them, would have been taken from the remainder of the levee line which would have been necessarily weakened thereby, and crevasses would, therefore, have been much more frequent.

In fact, if it could be predicted that the next great flood would be similar to the last, even a somewhat lower provisional grade line would be desirable in certain portions of the river, as 586 miles of levees have not been constructed to this grade, and some 53,000,000 cu.yd. must be placed in them to create the cross-section which has been adopted by the commission. But no two floods are similar. The grade line established by this flood will be subject to material changes, arising from variations in the discharge of the White, Arkansas and Red Rivers, or even from local rains.

All Completed Levees Held in the Flood of 1912

It will surprise many to learn that at none of the stations did the flood of 1912 reach a height equal to that of the provisional grade line, nor did a crevasse occur in any levee that was built to the grade and given the cross-section established by the commission, except possibly at Hymelia.

If the recommendations of the commission, made some 15 years ago, had been carried out, this disaster to a great extent, would have been averted.

I do not mean to imply by this statement that the provisional grade adopted by the commission is the ultimate grade to which levees should be constructed. In fact, they must ultimately be built at least from 2 to 3 ft. higher; but that if the provisional grade and cross-section had existed throughout the valley, wherever the flood attained a height greater than the provisional grade, there would have been a good fighting chance to hold the levees by topping, while with defective foundations and weak section, the battle was lost before the river could attain that height.

As a result of this flood the commission does not recommend any immediate change in its provisional grade; on the contrary, it is of the opinion that the first work to be done is to strengthen the foundations wherever any weakness has been observed, then to bring the section to standard dimensions. When the levee line is uniformly perfected to the provisional grade, its further enlargement will be advisable. Excessive strength in one locality, with the necessary undue weakness at others, should be avoided.

Protection of Caving Banks

While about 2,500,000 cu.yd. of the levee line was destroyed by crevasses during the last flood, over 4,300,000 cu.yd. had to be abandoned during the past year on account of caving banks. The loss from crevasses is considered a national calamity, while that from caving banks is scarcely noticed. But I desire to particularly invite attention to the drain upon the community this caving of levees into the river has become. It requires an expenditure of nearly $1,000,000 annually to replace them. The Mississippi River Commission appreciates the relief that Congress has afforded them by its proviso that $4,000,000 of the $6,000,000 appropriated by the last rivers and harbors bill must be expended on levees. It precludes the use of any funds for the protection of city parks or even city fronts. But there is a danger from too close a limitation of the powers of the commission. It frequently is cheaper to construct a bank revetment than to rebuild a levee which is caving into the river. I apprehend that under the present act several hundred thousand dollars will be wasted. Because of its limitations levees must be constructed where bank revetments are more desirable.

Foundations for Levees

The advice which the commission has received on the use of concrete, steel piles, triple lap sheet piling, and other patent innovations for levee construction, would fill a large volume. I will not detain you with a discussion of these devices further than to state that we are convinced from the results of the late flood that greater care must be exercised in securing the levee foundations, but whether this result will be attained by an enlarged muck ditch, a wall of concrete or sheet piling, or other means, is dependent so much on local conditions, that no general plan can at present be formulated.

Conclusion

The flood of 1912 affords no argument for the abandonment of levee construction. It has simply attained the height which Gen. Comstock and Maj. Starling predicted the flood of 1882 would have attained if the river had then been confined. It has cleared the atmosphere of certain false theories, and we can now resume operations with a definite knowledge of the problem before us. We are passing through the same experience European nations have had. Levees have been tested for ages, and have proved uniformly successful when built of adequate dimensions. During the progress of construction there were disasters on foreign rivers as well as in the United States. No other method of relief from floods has been successfully applied to large streams.

Originality is a very desirable quality in an engineer, but there is danger of confusing originality and ignorance. When a proposition with which he is unfamiliar is presented to him it is his duty to follow the instructions placed at some railway crossings, to stop, look and listen. He should investigate what has been done in the past, and seek to discover if there is no precedent for his action.

It was said several thousand years ago that there is nothing new under the sun. The saying is true today. To adopt a project, even though popular, that has been tried, found wanting, and rejected by our forefathers, is not progress, but retrogression.

The Diesel-Engined Ship, "Fordoman," built by the Clyde Engineering and Shipbuilding Company for use in the grain carrying trade on the Great Lakes, performed a series of trials, on Sept. 21. A speed of 10 knots an hour was exceeded; 63 reversals were accomplished in 42 minutes; complete reversal from full speed ahead to full speed astern took six seconds and in three seconds the engines were stopped from full speed. The driving engines are four cylinder, two cycle, Diesels of the Carels type, and develop 750 b.hp. at a normal speed of 120 r.p.m. An interesting and detailed account of the trial appeared in the Sept., 27, issue of London "Engineering".

Standards of Purity for Rivers and Waterways*

At a meeting of the National Association for Preventing the Pollution of Rivers and Waterways, held at Baltimore, Md., on Dec. 13, 1911, it was voted:

> that a committee of five members of the Association be appointed by the President to act as a Committee on Standards of Purity for Rivers and Waterways, with instructions to study the general subject in a broad way and to make a tentative report at the next annual meeting of the Association on the feasibility of establishing standards applicable to different conditions.

On Dec. 21, 1911, the undersigned were duly appointed by the President, Calvin W. Hendrick, to serve as members of this committee. We at once entered into correspondence and on June 27, 1912, met in New York for a conference.

The various matters involved have been considered in detail, but the present preliminary report is confined to certain fundamental propositions, about which there appears to be little difference of opinion among sanitary engineers. These propositions, with a few explanatory notes, are as follows: Your committee finds.

(1) That because of the increasing population of the country, the increasing tendency toward concentration of population in cities, the extension of agriculture, the increasing necessity of artificial fertilization and the growth of manufacturing, it is and always will be, physically impossible to maintain our rivers and waterways in their original and natural condition of purity. However much we may strive to the contrary, some pollution of the water is inevitable. A reasonable degree of cleanliness should nevertheless be demanded.

(2) That up to certain limiting points the use of our rivers and waterways as vehicles for the reception, transmission and ultimate disposal of sewage and other liquid wastes, is primarily an economic question. The discharge of raw sewage into our streams and harbors should not be universally prohibited by law.

(3) That the method of disposal of sewage by dilution is recognized as sound in principle and safe in practice, if carried on with proper restrictions. The power of streams to transport suspended matter, and the ability of natural bodies of water to oxidize and destroy offensive substances through the action of various physical, chemical and biological processes, represent a natural resource that should be utilized as far as this can be done with safety and economy and without offense.*

(4) That for each river and waterway at any given point, there is a limit to the amount of permissible discharge of waste matter. The reasons for this limit are not the same in all cases, but vary according to the use that is to be made of the river or of the water of the river, and according to the character of the territory through which it flows. No universal standard of purity can be wisely established or maintained.

(5) That when the extent of the pollution is such as to affect the public health in any way by any reasonable use of the river or the water of the river, the sanitary aspect of the situation should control and the degree of pollution should be regulated accordingly.†

(6) That when the extent of the pollution is such as to cause sensible offense to public decency in the course of any reasonable use of the river, this aspect of the situation may properly control.

(7) That when the extent of pollution is such as to cause material injury to fish or shellfish industries, or to the ice industry, this element may control.

(8) That when the extent of the pollution is such as to cause the silting up of the channels of navigable streams, this element may control.

(9) That even when the demands of public health, offense to decency and interference with navigation are such as to place a limit to the pollution of the stream, the economic aspects of the case should be considered in regulating the amount of permissible discharge of waste matter, the fundamental principle being that the results accomplished shall be reasonably commensurate with the cost of prevention of the pollution.‡

(10) That while no universal standard of purity applicable to all rivers and waterways can be established, it is believed to be feasible to establish and

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*Report of a Committee of the National Association for Preventing the Pollution of Rivers and Waterways, presented to the Association at Cleveland, Ohio, Oct. 23, 1912. The Committee consisted of George C. Whipple, Chairman, New York City; George M. Wisner, Chicago, Ill.; A. J. McLaughlin, Washington, D. C.; Edward Bartow, Urbana, Ill., and Harry W. Clark, Boston, Mass.

*This is in line with the present idea of conservation. It is believed that the use of these forces of nature may be just as valuable in their way as the use of certain streams for water power is valuable in its way. Not to take advantage of them where possible would be contrary to public economy. Some streams probably serve their best use to the general public as carriers and destroyers of waste organic matter. The point to be determined is as to how far these forces can be utilized without offense. The ordinary limits of dilution based on the ratio of the population or the volume of the sewage to the stream flow are not sufficient, as they fail to take into account the velocity of the current and the opportunities for aëration. Further data on this point are needed.

†This proposition involves the question as to what is a reasonable use of rivers and waterways, which is a matter to be determined for each particular case, and one that in the event of conflicts between different interests must at present be decided by the courts.

‡It is recognized that there are great demands upon cities for expenditures made in the interest of public health and comfort, and that the relative results obtained by expenditures for different purposes should be considered when budgets are being made up.

maintain appropriate standards of a general nature for waters that fall within certain particular groupings. Your committee has this matter under advisement, but is not prepared to report upon it in detail at this time.

(11) That inasmuch as the safety of public water supplies is the most important element in the problem of stream pollution at the present time, the following general principles should govern the discharge of sewage and waste matters into rivers and waterways.

(a) Streams from which water supplies are taken and used without purification should not receive any fecal matter, sewage, sewage effluent, or wastes that will render the water a menace to health or otherwise impair its natural quality.

(b) Streams from which water supplies are taken and used after purification should not receive fecal matter, sewage, sewage effluent or waste matters, in such quantities that the contamination of the water at any water-works intake would put an unreasonable burden upon the purification works, or in quantities sufficient to produce the conditions referred to in the next paragraph. The treatment of sewage or wastes required to produce this result may vary all the way from none at all, in the case of large streams where the pollution is very remote, to a thorough treatment if the pollution is large and near the water-works intake.

(c) Streams not used for water supply may receive sewage wherever, and in such quantities, that its entrance will not sensibly offend decency in the reasonable public use of the stream, or cause interference with navigation or with valuable fish industries, or the ice industry. Where this cannot be done the sewage or wastes should receive such treatment before discharge as to bring the effluent within this rule, due regard being given to the relative cost of the processes required and the benefits to be derived.

(d) Large lakes from which water is used for a public water supply without filtration should not receive any fecal matter, sewage or sewage effluent, within a distance of several miles from the intake, depending upon local conditions as to currents, and suitable provision should be made for disinfecting the water.

(e) Large lakes from which water is used for public water supply after filtration should not receive fecal matter, sewage, sewage effluents or other waste matters in such amounts or at such places that the water reaching the intake would be contaminated to the extent that an unreasonable load would be placed upon the filter, or in quantities sufficient to produce the conditions referred to in the next paragraph. The sewage treatment required to produce this result may vary in efficiency according to the distance between the sewer outlet and the water-supply intake, the nature of the currents and other local factors.

(f) Lakes not used for water supply may receive sewage if discharged in such a manner as to be quickly and thoroughly diluted, so that its entrance will not sensibly offend decency in the reasonable use of the lake, or interfere with navigation.

Where this cannot be done the sewage should receive such treatment before discharge as to bring the effluent within this rule, due regard being given to the relative cost of the processes required and the benefits to be derived.

(g) Harbors and tidal estuaries may receive sewage at such places and in such amounts that the discharge does not sensibly offend decency in the reasonable public use of the water, cause interference with navigation or with valuable fish or shellfish industries. Where this cannot be done the sewage should receive such treatment before discharge as to bring the effluent within this rule, due regard being given to the relative cost of the processes required and the benefits to be derived.*

(12) Thus, while recognizing that the pollution of many rivers and waterways is inevitable, and that absolute prevention of pollution is impossible, it is deemed imperatively necessary that some control over the discharge of waste matter into rivers and waterways be maintained in order that conditions prejudicial to the public health and comfort and damage to property may be kept at a minimum. The committee heartily indorses, therefore, the movement that is being made to keep the pollution of streams within reasonable bounds and not allow our rivers and waterways to become unduly soiled.

Your committee recommends the adoption by the association of these fundamental propositions, believing that they will serve as a basis for the establishment of more detail standards later, and will be helpful to those who at the present time are engaged in formulating policies in regard to this matter.

Your committee also requests that it be allowed to continue its work for another year, and that it be given power to confer with the Committee on River Cleaning recently chosen by the Section of Sanitary Engineering of the American Public Health Association, and, if thought desirable, to collaborate with this committee in the formulation of a joint report. [This request was granted and, in addition, the recommendations made were adopted as a temporary working basis.—ED.]

*The tenth proposition brings up the very important question as to what is a reasonable burden to place upon a water-filtration plant. The data for deciding this have not yet been secured. It is recognized that water-filtration plants are not infallible and that for this reason the work that they are called upon to do must not be too great. Until this fundamental question is settled, it will not be possible to formulate reasonable standards of purity for streams necessarily used both for sewage disposal and for water-supply. It is not out of place to here remark that often greater economy can be secured by abandoning water-supplies from polluted streams than by attempting to reduce the pollution to the required extent. The difficulty in doing this lies in properly adjusting the cost between the conflicting interests and raises some interesting questions of the policy of control that might be properly taken up for discussion by another committee of this association.

Water Pollution Conference

Some two years ago the National Association for Preventing the Pollution of Rivers and Waterways was formed for the study of the water-pollution problem in the United States and to promote measures for public control of water pollution. About the same time, or perhaps later on, there was formed the Great Lakes International Pure Water Association to deal with problems presented by the pollution of the Great Lakes. The two associations met at Cleveland, Ohio, Oct. 23 and 24. Except while transacting association business, which occupied but a small amount of time, the two associations met in joint sessions, of which four were held, and listened to the presentation and discussion of papers. A forenoon was devoted to a visit to the chlorination plant and pumping station of the Cleveland water-works and to the new sewage-testing or experiment station now nearly completed at the outlet to the lake-front intercepting sewer. The attendance was small, perhaps 50 to 60 from both associations.

A notable feature of the conference was the presentation of a "Progress Report on the Standards of Purity of Rivers and Waterways" by a committee created at Baltimore last December by the National Association for Preventing the Pollution of Rivers and Waterways. This report, which is printed in full elsewhere in this issue, and which was adopted by the association just named as a temporary working basis pending the final report of the committee, is by far the most promising specific achievement of the association and marks a step in advance. In harmony with this report, in so far as it dealt with the same subjects, was one presented to the Great Lakes International Pure Water Association by its Committee on Special Technical Investigation.

Many of the papers presented at the conference had either been read at earlier meetings this year, or were re-statements of data and opinions already in print. Nevertheless, the papers and the discussions which they provoked served the useful purpose of laying before the conference recent data on the water pollution and its relation to specific water supplies. Thus far there was general agreement with some disagreement as to details. Over preventive and remedial measures there were sharp differences of opinion. In general, the medical health officers not fully informed as to methods,

capabilities and costs of sewage treatment and water purification, maintained that water pollution must be stopped, and assumed that this can be done by means of "sewage purification," while the sanitary engineers, chemists and biologists, and a few well informed medical men, held that sewage disposal by dilution, when properly controlled, is not only safe but an economic necessity, and that for the protection of public water-supplies, chief reliance must be placed on water purification. The medical extremists argued for safety at any cost, adducing the familiar argument that "even if only one life were saved," etc., but the more rational view was also expressed that the funds available for sanitary work are limited and must be used where and how they will save the most lives.

Papers and Discussions

The first paper read was by Dr. Chas. J. Hastings, Medical Officer of Health, Toronto, Ont. Its title was "Why We Should Not Pollute Our Water Supplies." Data gathered by the Lake Michigan Pure Water Association and at Toronto were presented to show that sewage discharges into Lake Michigan and into Lake Ontario are swept into each lake beyond the practicable limits of water-intake tunnel extensions. In this paper and repeatedly during the conference Dr. Hastings plead for sewage treatment to protect water-supplies when water filters go wrong. He also plead that the sewage of the Great Lakes cities should be treated for the protection of boat passengers and crews dependent on drinking water taken from the lakes.

Dr. Hastings stated that Toronto is providing a double barrier for its own safety. It already filters its water-supply and subjects its sewage to sedimentation and is about to treat the sewage with hypochlorite.

H. E. Barnard and Jay A. Croven, of the Indiana State Board of Health, contributed a paper on "The Value of River Surveys." They described three months' work done in 1911 and again in 1912 on the Ohio and Wabash rivers, dealing with one river each summer. In general, a two-room house boat was the base of operations, with one room used as a laboratory. Samples were taken at one-mile intervals. Data on water-supply and sewage disposal were secured at cities. The object of the survey was to get data pertaining to the several towns for future use, rather than to study the rivers as a whole, but the survey led to immediate changes for the better in two water-supplies. The survey cost about $1400 a season. Next year the White River will be surveyed.

Dr. Allen J. McLaughin, of the U. S. Public Health Service, said that water-pollution surveys of the Missouri River were made during the past summer by the service in conjunction with four states and several cities, working at seven laboratories.

"A Study of the Water-Supply of Lake Michigan," by Dr. M. P. Ravenel and E. J. Tully, of the Wisconsin State Hygienic Laboratory, outlined three summers' work done in conjunction with the Lake Michigan Water Association. Samples were collected three days in a week for six weeks (apparently two samples a day), along lines at right angles to the shore extending out for seven miles into the lake, the work being carried on at six or seven Wisconsin lake cities. Relatively high bacterial counts were found even at seven miles out, or beyond the practicable limits of intake extension. [Data on the real significance of these counts from a practical viewpoint were not presented.—Ed.] The conclusion was drawn that intakes would have to be carried out 12 to 15 miles to get safe water; that each city problem demands separate study, and that probably the thing to do would be to treat the sewage by sprinkling filters and hypochlorite disinfection, and also to filter the water-supply. Pending the installation of plants for the latter the use of hypochlorite was suggested.

A review of the laws governing water pollution was read by James S. Cassidy, of Cleveland, a former member of the Rivers and Harbors Committee, U. S. House of Representatives. Mr. Cassidy expressed the belief that if Chicago was to tackle its sewage-disposal problem anew it would not inflict it on the valleys below and at the same time injure navigation and commerce by lowering the waters of the Great Lakes by diverting from Lake Michigan water for disposal by dilution. He also declared for a national bureau of health and a permanent national waterways commission.

This address stirred up discussion regarding lake levels and fish life in the Illinois River, both as affected by the Chicago Drainage Canal. No facts, new or old, were presented on the lake-level question; the opinions on the subject assumed that the levels were lowered, and that no further diversion should be permitted. Edward Bartow, Director of the Illinois Water Survey, stated that since the opening of the Drainage Canal the fish life and fish catch in the Illinois River have increased. This led Dr. Hodgetts, of the Canadian Conservation Commission, to challenge the quality of sewage-fed fish. Prof. Bartow informed him that fish do not feed on the sewage, but on lower organisms which have done so.

A specific constructive contribution to the discussion of water pollution was made by Paul Hansen, Engineer, Illinois Water Survey. In "Some Opinions on the Limitations of Stream Pollution," Mr. Hansen suggested two standards—each wholly tentative and to elicit discussion. The first standard was for waters used for public supplies after filtration; the second was for small streams used for recreation purposes, but not for public water-supplies.

It was suggested that the nearness of a sewage outlet to a water-works intake on a stream should be based on the time of stream flow between the two instead of on distance, and that the time should be ten hours at flood. In other words, no crude sewage should be discharged into a stream above a water-works intake near enough so that the sewage could reach the intake in less than ten hours during average flood flow. Where the distance was less than that represented by this ten-hour period then purification would be required, varying with local conditions from the simplest to the most complete.

At a four miles per hour flood flow this limitation would mean 40 miles between the sewer outlet and the water-works intake. With a low stream flow and velocity, say 0.2 miles per hour velocity, it would take 8⅓ days for the sewage to reach the water intake, during which time a large percentage of the bacteria in the sewage would perish. Of course, at flood flow there would be high dilution.

Taking up next streams used for recreation, and assuming that they receive no storm flow from cities, it might be demanded that sewage discharged into such streams be treated to prevent visible pollution near the outlet and that the effluent be disinfected, the latter for the protection of campers and other users of the shores and waters of the stream.

"The Necessity of Purifying Great Lakes Water-Supplies" was the topic of a well put talk by Dr. John A. Amyot, of the Ontario Provincial Board of Health. Lake Ontario studies at Toronto have shown an increase in total bacteria and coli counts with increase in population, and correspondingly typhoid in Toronto has increased. High counts have been shown 5, 8 and even 12 miles from shore. The high 12-mile count was not in the route of steamers and it is thought that the sample was taken from an "island" of sewage, blown out by the wind.

The effects of the wind at Toronto are marked. A long continued wind from either the east or the west drives out water and sewage pollution through the westerly and easterly gaps, respectively, between the mainland and either end of the island which forms the harbor at Toronto, and thus may infect the water at the intake beyond the island.

After reviewing evidence of pollution elsewhere on the Great Lakes, and remarking that aside from Lakes Erie and St. Clair the waters in question are not turbid, except for a few times a year at Toronto, Dr. Amyot said that the lake cities can get clear water by either slow sand or mechanical filtration, and that

once clear the water can be disinfected by hypochlorites, ozone or ultra-violet rays. The latter have not yet been used on a large scale. Ozone will disinfect water. In the last analysis, the action of both ozone and hypochlorite depends on nascent oxygen. Hypochlorite is readily applied and the resulting chlorine gas mixes readily with the water. Ozone requires complicated electrical machinery for its production, and to mix it with water is difficult. Then, too, variations in humidity add to the complications of ozone treatment.

Using ozone to disinfect water is like killing a dog with a gold plated hickory stick—the dog can be killed just as well without the gold plating.

The use of hypochlorites should be regarded as an emergency measure. The bleaching powder varies in value, and the dosing apparatus may not work or be worked uniformly. A 99% bacterial removal by hypochlorite does not mean as much as the same percentage removed by filtration, for a slow sand filter stops the huskies as well as the weaker bacteria, but chlorine does not act that way.

A paper by Geo. W. Fuller, of New York City, on "The Purification of Water from Standpoints other than Hygienic," seemed to be substantially the same as one presented in September at Washington, and printed nearly in full in our issue of Oct. 17, 1912, p. 700.

The discussion on the three last mentioned papers was postponed until all had been read. Dr. Hayward, of Detroit, said that the pollution of the Detroit water-supply from boats is serious. Boats pass on the Canadian side within a half mile of the intake, and if the wind is in the right direction pollution follows. Typhoid convalescents take trips on these boats.

Mr. Whittaker, of the Minnesota State Board of Health, said that studies of Duluth, not yet completed, show an increase in the pollution of the Lake Superior water supplied to that city. Dr. Hodgetts, of Ottawa, said that after engineers provide good filter plants, cities fail to operate them properly. In fact, he had seen filters idle for months at a time. In the same line, Dr. McLaughlin remarked that cities place good filters in the hands of assassins, who know nothing of either machinery or bacteriology.

Mr. Gorton, an engineer from Buffalo, referring to some remarks that had been made on sparing no expense to save even a single life, said that there is a limit on funds that can be raised by municipalities. When that limit is reached the money available must be apportioned where it will do the most good. In Buffalo there are as many deaths from scarlet fever and from diphtheria as from typhoid fever, and five times as many from tuberculosis. He thought a dollar spent in fighting tuberculosis would save twice as many lives as if used against typhoid.

Answering to the title, "The Sanitary Condition of the Cleveland Water-Supply," D. D. Jackson, of New York City, gave a lantern-slide talk in the course of which he presented tables and diagrams from his recent report on that subject. One of the main conclusions of that report, founded on studies at Cleveland, and of typhoid in relation to filtered and unfiltered water-supplies elsewhere, was that save for the spring rise in typhoid at Cleveland, the water-supply now causes but little of the typhoid there. Currents and winds, he believed, carried little or no pollution to the intake, except as ice is carried there at the spring break-up in the Cuyahoga River.

Chlorination of the water-supply seems to have been the cause of the elimination of the spring rise in 1912 and of a considerable part of the very low typhoid rate now promised for the whole year [perhaps 6 or less per 100,000; only 3 up to October—Ed.]. General improvements in sanitation probably account for the remainder of the reduction.

Mr. Jackson was no sooner through than Prof. Perkins, of Western Reserve University, Cleveland, was on his feet to take exceptions to some of the points in Mr. Jackson's Cleveland report. That 50,000,000 to 60,000,000 gal. of sewage could be poured into the lake daily without polluting the Cleveland water-supply, Prof. Perkins said, was counter to data on other lake supplies. Analyses [at his own laboratory—Ed.] showed bacterial fermentation throughout 1912. Chlorination and the screening of two-thirds of the open privies left in the city had doubtless cut down the typhoid, but there is a lack of data as to the causes of residual typhoid. Finally, Prof. Perkins said he could see no reason for changing his opinion that the water at the Cleveland four-mile intake is subject to pollution at intervals by causes beyond human control, and therefore chlorination should be regarded as only a temporary expedient, for use until a water-filtration plant could be provided.

Dr. McLaughlin expressed regret that Mr. Jackson's report conveys the idea that such large amounts of pollution as occur at Cleveland could disappear two miles from shore. As sanitarians, he thought those present must accept the finding of B.coli in 1 c.c. of water as evidence of contamination and endorse the conclusions of Prof. Perkins' long continued studies.

In closing the discussion, Mr. Jackson said he did not mean to give the impression that filtration was not desirable for the Cleveland water-supply or for any other surface supply, but merely that there was no immediate call for filtration at Cleveland, as it is not probable that filtration would greatly reduce the Cleveland typhoid rate. Even if the water were filtered, chlorination would be needed. Most large cities with filtration plants, he added, are using hypochlorite.

The problem at Cleveland is complex. What can be done with the funds at hand? It is conceded that changes in sewage disposal are needed. A duplicate water intake is also needed, both for general safety and to make it possible to put one intake out of service for cleaning.

Later on, when other needs have been met, Cleveland might filter its water-supply, with the expectancy that the results will be largely esthetic and that typhoid will not be affected thereby—no more than it has been in some other cities with filtered water-supplies.

Finally, Mr. Jackson remarked that if any single primary cause of typhoid spread is reduced contact cases are also reduced, and contact cases make up 50% of the total.

Dr. Allen J. McLaughlin, of the U. S. Public Health Service, gave a brief talk on sewage pollution of the Great Lakes. So long as cities exist, such pollution will be considerable, regardless of any sewage treatment which is economically feasible. Water purification stands first in importance, but sewage treatment may be an aid. The various methods of sewage treatment now in use are employed to prevent nuisance. The sewage discharged into the Great Lakes is so much diluted as to limit nuisance. The reasonable use of waterways for sewage dilution is an economic necessity, and the absolute prohibition of such use is of doubtful legality. Finally, a reasonable use of interstate waters for sewage disposal should be permitted and reliance be placed on water purification where safeguards are necessary.

Dr. Hastings, in discussion, asked why water should be purified for the protection of cities while boat passengers and crews are left to drink polluted water. Mr. Gorton replied that boats could be supplied with safe water at reasonable expense. Dr. McLaughlin added that as for boats on interstate waters, an order has been prepared but not yet issued at Washington requiring all such boats to take drinking water from certified sources. The states could exercise similar control over interstate waters.

The final paper, by W. G. Sherman, of Toledo, Ohio, was designed to show the need for control of all sanitary matters, through national, state and municipal boards of health, with concurrent action in international matters.

Business Proceedings

Acting on a suggestion made by C. E. Ford, Secretary of the Cleveland Board of Health and President for 1911-12 of the Great Lakes International Pure Water Association, a committee representing the joint meeting was appointed

to consider the consolidation of the two associations. This committee consisted of H. de B. Parsons and Geo. C. Whipple, of New York; Edward Bartow, of Urbana, Ill.; Dr. John A. Amyot, of Toronto, and Dr. Harper, of Wisconsin. It is expected that the joint committee will confer with the executive committees of each association.

NEW OFFICERS—For the National Association, Brig.-Gen. Torney, Surgeon-General, U. S. A., was elected President to succeed Calvin W. Hendrick; and H. de B. Parsons was re-elected as Secretary-Treasurer. For the Great Lakes International Association, Dr. Chas. J. Hastings, Health Officer of Toronto, Ont., was elected President to succeed Dr. C. E. Ford, and Paul Hansen, Urbana, Ill., was elected to succeed Prof. Edward Bartow.

Mine Rescue Measures

The following recommendations were made by the Resolutions Committee of the National Mine Rescue and First-Aid Conference at Pittsburgh, Penn., on Sept. 25, their object being the reduction of the unnecessary hazards in connection with mining operations, particularly coal mining.

RESCUE APPARATUS AND TRAINING

That such breathing apparatus as may be used for mine-rescue and mine-recovery work shall be of those types that have passed the tests of the Bureau of Mines.

The course in rescue training outlined by the Bureau of Mines schedule for educational purposes and for familiarizing miners with the use of the breathing apparatus ,should be followed, and for actual mine-rescue work, supplemental and practical training of two hours each should be taken at intervals of not more than three months.

All mine-rescue stations should be equipped with at least five sets of breathing apparatus and the necessary accessories for the continuous operation of the apparatus for 24 hours, and at remote stations, 48 hours. Such equipment should be so located as to admit of its assembly in one hour at a central point for emergency use.

Birds and mice should be kept at rescue stations for the purpose of detecting carbon monoxide.

All persons, before being admitted for rescue training, should present a medical certificate qualifying them for rescue work and insuring their freedom from contagious diseases.

The Bureau of Mines should prepare lists of stations, together with the names and addresses of the persons who have completed training with mine-rescue apparatus, and the names should be listed on a mine-rescue roll of honor and submitted to the local press for publication in the various mining localities—volunteers to be compensated for services and considered when promotions are being made.

The smoke room is best adapted for the first course of training. In addition to the above training as prescribed by the Bureau of Mines outline, supplementary practice to be taken underground is desirable.

RESCUE OPERATIONS

In rescue work untrained men should not be permitted to use breathing apparatus except when it is the only chance to save a life, and in selecting untrained men it should be remembered that discipline is of equal importance to training.

The following outline of procedure should be used before and after entering a mine following an explosion or a mine fire:

Outside Organization

1. All openings should be carefully guarded.
2. There should be a man in charge of outside arrangements to see that ventilating appliances are put in condition for operation so as to be ready to operate when conditions require it.
3. Good, competent men should be placed at all openings to the mine and should obey the orders given.
4. A competent person should be placed near the entrance to the mine to examine all safety lamps before they are allowed to be taken into the mine.
5. Some specified person should be placed at the entrance to check off all persons and make a record of same when they go into and come out of the mine.
6. Proper provisions should be made in the way of food and shelter to take care of parties engaged in rescue work.
7. A physician should be on hand while rescue parties are in the mine.
8. Safety lines should be established around all openings, inside of which lines no open lights should be allowed.
9. A man should be put in charge of the rescue squads to organize and have them ready to enter the mine when called upon.

Inside Organization

1. One man should have full charge of the inside operations on each shift.
2. An advance squad under a competent leader should explore the workings in advance of the other squads, which should proceed in the following order:
   a. Breathing apparatus or advance squad.
   b. Stretcher squads.
   c. Temporary ventilation squad.
   d. Material squad.
   e. More permanent ventilation squad.
3. A station should be established, which would form a base of operations from which to work, and a competent person should be put in charge who would re-examine all lights before they pass beyond him to the interior of the mine.
4. A telephone should be established at this station to communicate with the surface, and be carried into the workings as fast as possible.
5. No person should go in advance of the ventilating current except the advance squad, which should make an examination of the atmosphere for gas, and examine the return air current frequently for indications of fire; also for any other dangers which are likely to exist.
6. A doctor should be stationed at this inside station with necessary supplies for his use.
7. While advancing into the mine all unexplored openings should be dangered off.
8. Strict discipline should be maintained at all times.

Owing to the different conditions in different mines and the hazardous work undertaken, the question of the maximum distance rescue crews should proceed beyond fresh air, should be left to the decision of the official in immediate charge, in conjunction with the mine officials, and the probability of being able to save human life, using the time limit on all explorations.

The shift should not exceed two hours, except when absolutely necessary. This should be followed by not less than six hours' rest.

SAFETY LAMPS AND ELECTRIC LAMPS

No open light should be used.

In coal mines only such types of safety lamps and electric lamps as have passed the tests of the United States Bureau of Mines should be used.

Electric lamps unaccompanied by safety lamps should not be used unless the party is equipped with breathing apparatus.

Both safety lamps and electric lamps should always be used up to the point where breathing apparatus is put on and beyond such point no safety lamps should be used except one carried by the leader of the party, if explosive gas is not present in dangerous quantities.

The conference also adopted resolutions on the subjects of the duties of first-aid men, the best system of first-aid training, the coöperation of mining-company officials and employees, and the requisite number of first-aid men for best efficiency of the service.

There was discussion as to the relative merits of contests and exhibitions in arousing interest in rescue and first-aid work and methods of conducting and judging contests were suggested.

The question of the advisability of providing underground hospitals was taken up and the general opinion was that a thorough distribution of first-aid equipment at various points in the mine would be less expensive and more efficient in case of accident.

Action was taken on a resolution to make the conference a permanent organization and a committee was delegated, with H. M. Wilson as president, and C. S. Stevenson as secretary, to draw up a constitution and by-laws for this permanent society.

Notes from Engineering Schools

COLUMBIA UNIVERSITY—Teachers' College is offering a series of evening courses for men employed in engineering work who desire further advancement. There are courses in drafting and designing for beginners and for experienced men.

A new course was opened Oct. 25, covering advanced problems of steel-structure design. This course is given by A. E. Casani, a designer with the American Bridge Co. An elementary course in the strength of materials is given also on Friday evenings, and an elementary course in structural design on Tuesday and Thursday evenings.

TULANE UNIVERSITY—Three courses in sanitary science have been started this year. These are for medical, science and engineering students who desire to specialize in sanitation. The medical graduates expect to become health officers on boards of health; the science graduates look forward to being experts in sanitary biology; the engineering students will specialize in the design, construction and maintenance of structures for sanitary purposes. For the senior class in sanitary engineering, instruction will be given in water-supply,

framed structures and reinforced concrete by Prof. Donald Derickson, formerly of Cornell University. Instruction and laboratory work in sanitary biology is to be given by Dr. Creighton Wellman and his assistants in the School of Tropical Medicine, which is located at this University.

PENNSYLVANIA STATE COLLEGE—Under the direction of Prof. J. A. Moyer, of the Mechanical Engineering Department, a series of investigations is being made on the use of kerosene in gasoline engines. This work is being done to develop a satisfactory carburetor for kerosene. An engine has been installed and equipped to utilize either oil or gasoline fuel. Experiments will be made on various fuel mixtures and a carburetor valve will be designed to shift the fuel supply automatically from a small gasoline tank used for starting to the main (kerosene) tank.

A Southern Pacific Excursion Train was derailed near Lake Charles, La., on Oct. 21 and several passengers slightly injured. Press reports state that the train had just crossed over a burning trestle, when it gave way and caused the derailment of the last three cars.

The Hurricane in the Philippines on Oct. 16 is estimated to have done $25,000,000 worth of damage among the islands, according to dispatches from Manila. Sail boats and steamers were wrecked, houses were destroyed, and the crops of hemp, sugar, and cocoanuts were ruined in the storm's path. Press reports place the number of casualties at about 400, all among the natives.

A Fire on the Steamer "Berkshire," of the Merchants and Miners Line, on Oct. 20, caused the boat to put into Cape Lookout Cove, where two days later she sank from the water poured into her to quench the fire. The cargo consisted of cotton and when the fire was discovered it was beyond control. Wireless calls for assistance were answered by three ships, including a revenue cutter, which stayed with the "Berkshire" until the fire was put out and helped take the passengers from the burning boat.

Malicious Attempts to Derail Trains were reported by President Mellen of the New York, New Haven & Hartford R.R. at the annual stockholders' meeting as follows:

"From Jan. 1, 1908, to Oct. 15, 1912 there have been placed 149 obstructions on our tracks for the purpose of derailing trains. This is an average of one in less than every 12 days for the period, and since the first of this year there have been 61 cases, or an average of one a week. Many of these obstructions were on our main line between New York and Boston. That is the community in which we are living; that is one of the difficulties under which we are contending and it indicates a state of feeling in the popular mind that affords you food for thought. Doesn't it indicate there is something wrong?"

Concerning the Cause of the Westport accident on the New York, New Haven & Hartford R.R., on Oct. 3, last, Mr. Charles S. Mellen, President of the railway company has made the following statement:

Our records show an average weekday use of 867 cross-overs in every 24 hours for the lines between New York and Boston. Assuming the same density of traffic as at present and for a 20-year period, a serious wreck has resulted in an average of 1 in 3,000,000 times of use of such cross-over movements. There is no automatic invention to our knowledge in existence that is available, and I believe from our experience with automatic devices of all kinds that there is none that will show the margin of safety that the use of cross-overs under the rules of the company has given upon our lines.

Among the misstatements regarding the company's attitude, none is more annoying or untrue than that we have ignored the recommendations of the Interstate Commerce Commission as a result of the findings in the case of the Bridgeport disaster. There was a report made by an inspector employed by the Commission in which some recommendations were made to the Commission, but no recommendations have been made by the Commission as a result of that report to this or any other railroad in this country so far as my knowledge goes at the present time. [Boston "Evening Transcript."[

Girderless Floors of Reinforced Concrete have been investigated recently under the direction of the Commission of Buildings, at Chicago. The building code of that city provides only for beam and slab construction, and the developments in girderless or plate floors have made it necessary to obtain special rulings from the Commissioner in regard to the use of floors of this latter type. During the past twelve months three patented forms of such floors have been reported upon by three commissions of engineers; these commissions are appointed by the Commissioner of Buildings, and the parties interested in each case pay all expenses of the investigations.

The New Grand Central Terminal in New York City is rapidly approaching completion. On Oct. 28, the suburban concourse, the lower level of the station, leading directly to the subway and the street, was opened to passengers and most of the suburban trains were run into it. This concourse is entirely separate from and is to have separate appointments to the main through travel concourse on the first floor.

The Breslau Concrete Dome is now nearing completion. It will be the largest masonry dome in existence, having a diameter of 213 ft. Its frame comprises 32 ribs, abutting on a 50-ft. central ring. Construction work was begun about a year ago. The dome is the central feature of a great municipal memorial hall being built for the city of Breslau, Germany. The whole building is constructed of reinforced concrete.

The Train Ferry Around New York City by which the Boston-Washington express trains of the New York, New Haven & Hartford R.R. and the Pennsylvania R.R. were taken from the Pennsylvania terminal in Jersey City to the New Haven terminal on the Harlem River at Port Morris, has been abandoned. The official announcement states:

The abandonment of the car floats is due to many hazards beyond the control of the railroad transfer steamers. The water traffic, now very heavy, is growing fast. Fogs, which can be counted upon with the approach of winter, add to the risk. The Colonial Express will run into the Grand Central terminal and transfer passengers by motor bus across New York to the new Pennsylvania terminal. The Colonial will run via the Shore Line between New York and Boston. The Federal Express will run between Boston and Washington without change of cars, via the Shore line between Boston and Naugatuck Junction, Conn. Between Naugatuck Junction and Maybrook, N. Y., over the New Haven and Central New England; between Maybrook and Belvidere, Penn., over the Lehigh & Hudson, and between Belvidere and Washington over the Pennsylvania via Trenton and Philadelphia. With the completion of the bridge across the Hell Gate, the connecting railroad will make a new short all-rail route between Washington and Boston which will do away with the new route via Maybrook.

Government-Owned Railways of the World.—The percentage of government-owned railways of the world, according to E. A. Pratt in the London "Times," is 29.1% of the total 639,621 miles computed by the *Archiv fur Eisenbahnwesen*. In 1898, Mr. Pratt submitted to the Viceregal Commission on Irish Railways, a set of tables then prepared, showing the proportions of the two types, company-owned lines and government-owned lines, as far as the available data permitted him. The computation thus prepared was for 562,436 miles, of which only 12,644 miles were not accounted for. At that time, the company-owned precentage was 69.1%, government owned 28.7%, and unaccounted for, 2.2%. This information has been tabulated in five grand divisions, and the American continent, although constituting nearly half of the total mileage of the world, to be exact, 326,832 miles, has only 3.7% of government-owned railways. As might be expected, the grand division, taking in Australia, Queensland, Hawaii, and adjacent islands, has the largest proportion of government-owned lines, namely, 96.3%. The total mileage of this grand division is 19,262 miles. In Europe, the government and privately owned property is nearly balanced, there being 107,663 miles of state-owned railways, or 51.9% of a total of 207,295 miles. Germany, Austria-Hungary, Italy, Norway, Roumania and Bulgaria, as well as European Russia, has a far greater proportion of government-owned lines than privately owned, all cases averaging about 80% and for Germany, 91.1%. Asia, with its 63,291 miles of line, has 58% owned by the government, while Africa, with 22,890 miles, has 59.7% owned by the government. This, however, includes the Rhodesia line as government-owned, which is not strictly true, as 2347 miles of railway built in or for Rhodesia are owned by six separate companies, but are operated by the Mashonaland Ry. Co. The lines, however, were constructed through the instrumentality of the British South Africa Co., which, in the case of some companies, guaranteed payment of interest on debenturesa mounting on Mar. 31, 1912 to £11,310,000.

According to Van Wagenen's "Government Ownership of Railways," in all the countries of the world except England and the United States there are about 99,000 miles of privately owned lines and 220,000 miles of government lines.

The U. S. Battleship New York was launched, on Oct. 30, from the Brooklyn Navy Yard, where it is now under construction by the Government forces directed by the naval constructors of the U. S. Navy. The general dimensions of the "New York" are as follows:

Length on water line.....565 ft.
Breadth on water line.....95 ft. 2⅝ in.
Mean trial displacement.....27,000 tons
Mean draft.....28 ft. 6 in.
Speed on trial, not less than....21 knots

The machinery consists of triple-expansion reciprocating engines of 28,100 hp., driving two propellers. She will carry ten 14-in. guns in her main battery.

Internal Combustion Locomotives are to be used on the construction of the Australian Transcontinental Ry., according to an item in "The Railway Engineer," on account of the waterless desert country traversed by this new line to the west coast. These will be mainly small contractors' engines, such as have been used elsewhere (Engineering News, May 9, 1912, p. 872), but it is suggested

that the experience with them may assist in the development of larger engines of the same type to handle the traffic when the railway is in operation.

The ceremony of cutting the first sod to start the construction work was performed Sept. 14, and it is expected that the line will be completed within three years. It will be of standard gage, about 1060 miles in length, and is estimated to cost $20,000,000, or $18,868 per mile.

Federal control of wireless telegraph stations is being organized by the Department of Commerce and Labor for the enforcement of the recent act of Congress which takes effect Dec. 13. All wireless apparatus and operators working across state lines, or able to communicate to sea, must be licensed. It is estimated that several thousand amateurs fall within the scope of the act, besides some four hundred American vessels, and a hundred commercial stations, and as many more stations connected with colleges, schools, and laboratories.

The country has been divided into nine districts with headquarters at Boston, New York; Baltimore, Savannah, New Orleans, San Francisco, Seattle, Cleveland, and Chicago. Ship stations are divided into classes for (1) passenger, (2) cargo, and (3) small vessels with voluntarily installed equipment. Land stations are divided into a number of classes such as shore, general public-service, limited-commercial, experimental, school, amateur and special-class stations. Operators are divided into commercial, amateur, and technical classes. There are five sub-grades in the first class, two in the second and two in the third.

The act provides that every station must designate a certain definite wave length as the normal sending and receiving length of the station. This must not lie between 600 and 1,600 meters unless this figure is changed by the Secretary of Commerce and Labor to accord with later international agreements.

Stations on shipboard must be prepared to send distress calls on a normal wave length with a transmitter tuned to create a maximum of interference with a maximum of radiation. All shipboard stations wherever practicable must be prepared to send distress signals with sufficient power to be received by day over sea at a distance of 100 miles. All stations are required to give absolute priority to distress signals and to cease all sending on hearing such.

Shipboard stations when within 15 miles of a naval or military station must not use a transformer input exceeding 1 kw. When within five miles of such stations, the transformer input must not exceed ½ kw. except for sending distress signals. Each shore station giving general public service between the coast and vessels at sea is bound to exchange messages with any similar shore station and with any ship's station without distinction to the commercial systems adopted. Each shore station during the hours of operation must listen at intervals of not less than 15 min. and for a period of not less than 2 min. for distress signals.

At important seaports and where naval or military and private or commercial shore stations operate in close proximity, so that interference cannot be avoided by the regulations concerning wave lengths and character of signals, then the time of use is to be divided. Private and commercial stations are not allowed to use their transmitter during the first 15 min. of each hour, local standard time, and the government stations must use only the first 15 min. except in case of signals relating to vessels in distress.

Private or commercial stations not engaged in the transaction of bona fide commercial business or in experiments with the development and manufacture of apparatus for commercial purposes may not use a transmitting wave length exceeding 200 meters, or a transformer input exceeding 1 kw. except by special authority.

The penalty for violation of the regulations in respect to licenses is fixed at $100 for an owner of apparatus and $25 for an operator, but these sums may be reduced or remitted by the Secretary of Commerce and Labor. Willful interference with communication as defined by the regulations is deemed a misdemeanor and is punishable by a fine of not to exceed $500 or one year in prison for an owner or operator. The penalty for transmitting false distress signals is fixed at not more than $2,500 or imprisonment for not more than 5 years or both. The penalty for transmitting any false signal call is placed at $1,000 or 2 years in prison or both. Wireless apparatus on foreign ships in territorial waters of the United States does not have to be operated in accordance with the requirements of the regulations except as they apply to sharp waves, distress signals, and interference.

Trials for offenses under the act are to be in the district in which the offense is committed. If the offense is upon the high seas or out of the jurisdiction of any particular state or district, trial is to be in the districts where the offender may be found or into which he may be first brought.

Personals

Mr. L. L. Beall has been appointed Engineer of Maintenance-of-Way of the Atlanta, Birmingham & Atlantic R.R. at Atlanta, Ga.

Mr. A. B. Ziegweid has been appointed Division Engineer in charge of maintenance-of-way and structures of the Pere Marquette R.R., at Saginaw, Mich.

Mr. J. B. Gant, formerly Inspector of Bridges of the Illinois Central R.R., has been appointed to a similar position with the Grand Trunk Ry., at Montreal, Que.

Mr. L. F. Lonnbladh, Chief Engineer of the Tennessee Central R.R., at Nashville, Tenn., has been appointed Superintendent with office at Nashville, succeeding Mr. L. S. Bourne, resigned.

Mr. Herman Nieter, until recently General Sales Manager of The Kennicott Co., of Chicago, Ill., has become associated with the Blaw Steel Construction Co., at 165 Broadway, New York City.

Prof. George W. Eckhard, recently in charge of the civil engineering department at Milliken University, has been appointed Assistant Professor of structures at the Pennsylvania State College.

Mr. N. R. Howard, Assistant Superintendent of the Chicago, Burlington & Quincy R.R., at Galesburg, Ill., has been appointed Superintendent at Burlington, Iowa, succeeding Mr. O. E. Stewart, resigned.

Mr. C. H. Hartwell, recently Chief Draftsman of the Wheeling & Lake Erie R.R., at Cleveland, Ohio, has been appointed Division Engineer of the Chicago & Alton R.R., with headquarters at Mexico, Mo.

Mr. E. L. Magers, Assistant Superintendent of the St. Louis & San Francisco R.R., at Fort Scott, Kan., has been promoted to be Superintendent of Terminals at Memphis, Tenn., succeeding Mr. J. M. Walsh, resigned.

Prof. R. J. Durley, M. Inst. C.E., of McGill University, Montreal, Que., has been awarded the Crampton prize of the Institution of Civil Engineers of Great Britain for a paper presented during the 1911-1912 session.

Prof. Wm. H. Burr, M. Inst. C.E., of Columbia University, New York City, has been awarded the Watt gold medal of the Institution of Civil Engineers of Great Britain for a paper presented during the session of 1911-1912.

Prof. O. J. Ferguson, of Union College, Schenectady, N. Y., has been appointed Professor of electrical engineering of the University of Nebraska, succeeding Prof. G. H. Moore, who has resigned to engage in private practice.

Mr. Paul A. Seurot, M. Am. Soc. C.E., of East Orange, N. J., was awarded a Telford premium of the Institution of Civil Engineers of Great Britain for a paper published in the "Proceedings" of the society for 1911-1912.

Mr. Alexander Allaire, Manager of the Foundation Co., Ltd., of Canada, at Montreal, Que., has been appointed Manager of the Western department of the company at Winnipeg, Man. Mr. R. Chadwick succeeds Mr. Allaire at Montreal.

Mr. James Riley, former Electrical Engineer and Superintendent of Motive Power and Equipment of the Choctaw Ry. & Lighting Co., McAlester, Okla., has been appointed Electrical Engineer of the Missouri, Kansas & Texas Ry., at Parsons, Kan.

Prof. J. A. Moyer, M. Am. Soc. M.E., formerly Assistant Professor of mechanical engineering at the University of Michigan, has been appointed Professor and head of the department of mechanical engineering at the Pennsylvania State College.

Mr. A. G. Abell, former Superintendent of the St. Louis, Iron Mountain & Southern Ry., at Monroe, La., has been appointed Superintendent of the Lousiana Ry. & Navigation Co., with headquarters at Shreveport, La., succeeding Mr. W. H. Coppage.

Mr. Christopher Henry Snyder, M. Am. Soc. C.E., Pacific Coast Manager at San Francisco, Calif., for Milliken Bros., Inc., of New York City, has resigned to enter private practice as Designing and Consulting Engineer, with offices at 251 Kearney St., San Francisco.

Mr. John B. Lamson, a graduate of the department of agriculture, Iowa State College, has been appointed Agriculturist of the Chicago, Burlington & Quincy R.R. This is a newly created office designed to assist the farmers along the company's lines in scientific farming methods.

Mr. George E. Long, former Treasurer of the Joseph Dixon Crucible Co., Jersey City, N. J., has been elected Vice-President, succeeding the late Wm. H. Corbin. Mr. J. H. Schermerhorn, formerly Assistant Secretary and Treasurer, has been appointed Treasurer to succeed Mr. Long.

Mr. F. G. Frink, Assoc. M. Am. Soc. C.E., has been granted a year's leave of absence from his duties as Professor of railway engineering at the University of Oregon, to allow for his recovery from a severe illness. He will, however, continue his consulting practice at Eugene, Ore.

Mr. Frank G. Baum, M. Am. Inst. E.E., has been appointed Chief Engineer of construction of the Pacific Gas & Electric Co., San Francisco, Calif., succeeding to the duties of the late James H. Wise, Assistant General Manager. Mr. Baum has hitherto been Consulting Engineer for the company.

Mr. W. B. Thomson, Assoc. M. Am. Soc. C.E., formerly Assistant Engineer of the Boston & Albany R.R., at Springfield, Mass., has been appointed Chief Draftsman of the Wheeling & Lake Erie R.R., at Cleveland, Ohio, succeeding Mr. C. H. Hartwell, whose resignation is noted elsewhere in these columns.

Mr. Hollis Godfrey, Consulting Industrial Engineer, of West Medford, Mass., has provisionally been appointed Chief of the Bureau of Gas, Department of Public Works, Philadelphia, Penn., at a salary of $5000 per annum, pending the appointment of a permanent bureau head from the civil service list.

Mr. Fred W. Boettler, formerly Assistant Engineer in the public works department of Milwaukee, Wis., has been appointed Instructor in civil engineering at Marquette University, Milwaukee, succeeding Mr. J. E. Pinney, Jr., who has been appointed Superintendent of bridges and buildings of the city of Milwaukee as noted in our issue of May 16.

Mr. Chas. H. Hix, Vice-President and General Manager of the Seaboard Air Line Ry., has resigned. Mr. Hix began his railway work as a rodman with the engineering corps of the Norfolk & Western R.R. He soon changed to the operating department as a receiving clerk, and passing through the grades of station agent, train dispatcher and trainmaster, he became Division Superintendent in 1901. Four years later he was promoted to General Superintendent.

Obituary

Edward L. Jones, Assistant Professor of mechanical engineering at Lehigh University, died at his home in South Bethlehem, Penn., on Oct. 18. Prof. Jones graduated from Stevens Institute of Technology in 1892, and had been connected with Lehigh University since 1905. He was 43 years old and is survived by a widow.

Maunsel White, M. Am. Inst. M.E., died, Oct. 22, at his home in New Orleans, La. He graduated from Stevens Institute of Technology in 1879 and for many years was Engineer of Tests for the Bethlehem Steel Co. While with the Bethlehem Steel Co. Mr. White was associated with Mr. F. W. Taylor, M. Am. Soc. M.E., and together they invented the Taylor-White process of treating modern high-speed tools, now used throughout the world, and for which they received a gold medal at the Paris Exposition in 1900 and the Elliott Cresson gold medal of the Franklin Institute, of Philadelphia. Since 1905 he had been in consulting practice in New Orleans. He was widely known as a metallurgist and expert in the metallurgy of iron and steel. Mr. White was also a member of the American Society of Mechanical Engineers and of the Iron and Steel Institute of Great Britain.

Vaughan Pendred, M. I. Mech. E., for many years Editor of "The Engineer," of London, Eng., died recently at his home in Streatham. He was born in Ireland in 1836. His father was a classical scholar of note and his mother a highly educated woman. He never attended a school of any kind; from his parents and from two resident governesses he obtained his early education, and from his love of books and reading he acquired a mastery of many subjects. His parents were poor and his success in engineering was the result of pertinacity and hard study. While still a child, together with his brother, Hamilton, who also lived to achieve fame as an engineer, he built models of steam engines from odds and ends of brass and iron which they could lay their hands on.

Vaughan Pendred was the inventor of an electric arc lamp and of other devices, which, however, he never sold or exploited, with the exception of the Nozzle boiler, invented when he was still a young man. This boiler was of the vertical type with a rectangular firebox. Water-tubes crossed the firebox in both directions with a slight inclination. Across the higher ends extended a trough, with partitions, directed upwards; across the lower ends was a similar trough pointing downwards. The troughs, or nozzles, assisted circulation and very good evaporative results were attained.

In 1862, Mr. Pendred first came to England to become an engineer. He succeeded in obtaining a position with a small firm in Covan, Staffordshire, which made traction engines and agricultural machinery. He had early begun to write letters and articles for the technical magazines and shortly after coming to England he became Editor of the "Mechanic's Magazine." In 1865 he became Editor of "The Engineer;" he was then 29 years of age. From 1865 to 1905, he devoted his entire attention to this work. To him credit is given for bringing out illustrations of current practice in machine design. Previous to his editorship engineering journals had depended upon what they could glean from patent office drawings, and it was his influence which persuaded machinery and engine builders to permit the reproduction of their working drawings.

Mr. Pendred was a member of the Iron and Steel Institute, the Institution of Mechanical Engineers, the Society of Engineers, and an honorary member of the Cleveland Institute of Engineers. He contributed few papers to these or other societies; all his time and energies were devoted to "The Engineer."

He is survived by a widow and three sons, one of whom, L. St. L. Pendred, is now Editor of "The Engineer."

Engineering Societies

COMING MEETINGS

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS
Nov. 12-15. Annual convention at Dallas, Texas. Secy., A. P. Folwell, 50 Union Square, New York.

RAILWAY DEVELOPMENT ASSOCIATION.
Nov. 17. Annual meeting at Cincinnati, Ohio. Secy., W. Nicholson, K. C. So. Ry., Kansas City, Mo.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 19. Annual convention at Washington, D. C. Secy., W. H. Connolly, Washington, D. C.

AMERICAN CIVIC ASSOCIATION.
Nov. 19-22. Annual convention at Baltimore, Md. Secy., Richard B. Watrous, Union Trust Bldg., Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 20. Annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York.

NATIONAL FOUNDERS ASSOCIATION.
Nov. 20-21. Annual convention at New York, N. Y. Secy., J. M. Taylor, 29 So. La Salle St., Chicago, Ill.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 21-22. Annual meeting at New York, N. Y. Secy., D. H. Cox, 29 W. 39th St., New York.

AMERICAN MINING CONGRESS.
Nov. 25-28. Annual convention at Spokane, Wash. Secy., J. F. Callbreath, Denver, Colo.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 2-3. Annual meeting at New York City. Secy., W. H. Ross, 154 Nassau St., New York.

NATIONAL COMMERCIAL GAS ASSOCIATION.
Dec. 2-5. Annual meeting at Atlanta, Ga. Secy., Louis Stotz, 29 W. 39th St., New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 3-6. Annual convention at Cincinnati, Ohio. Secy., E. L. Powers, 150 Nassau St., New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 3-6. Annual meeting at New York City. Secy., C. W. Rice, 29 W. 39th St., New York.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 4-6. Annual meeting at Detroit, Mich. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 5-7. Annual convention at Philadelphia, Penn. Secy., C. A. Prosser, 105 E. 22d St., New York.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 9-12. Annual meeting at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Penn.

NATIONAL ASSOCIATION OF CEMENT USERS.
Dec. 10-14. Annual convention at Pittsburgh, Penn. Secy., E. E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 26-28. Annual meeting at Chicago, Ill. Secy., C. O. Reed, Urbana, Ill.

American Institute of Consulting Engineers—A meeting of the Institute was held on Oct. 25 in New York City, for the purpose of discussing methods of securing expert evidence in cases at law. E. W. Stern, 103 Park Ave., New York, is the Institute secretary.

American Society of Mechanical Engineers—Edward B. Passano, of Baltimore, Md., will present a paper on "Measuring Efficiency in Manufacturing," at the Society meeting on Nov. 12, in New York City. An informal dinner will precede the meeting.

Canadian Society of Civil Engineers—On Oct. 24, a meeting of the Society was held at Montreal, Canada, and a paper was given on "The Hydro-Electric Plant of the Sherbrooke Railway and Power Company," by C. L. Cate. Information concerning meetings of the Society can be obtained from the secretary, C. H. McLeod 413 Dorchester St. West, Montreal, Canada.

Society of Naval Architects and Marine Engineers—The 20th annual meeting of the Society will be held in New York City, on Nov. 21-22. Following are some of the papers which will be presented: "The Design and New Construction Division of the Bureau of Construction and Repair, Navy Department," by R. H. Robinson; "Engineering Progress in the U. S. Navy," by G. W. Dyson; "Marine Lighting Equipment of the Panama Canal," by James Pattison; "Oil Fired Marine Boilers," by E. H. Peabody; "The Preservation of the Metals Used in Marine Construction," by Frank Lyon; "Notes on Fuel Economy as Influenced by Ship Design," by E. H. Rigg; and the "Logarithmic Speed-Power Diagram," by F. M. Gunn. The Society secretary, Daniel H. Cox, 29 West 39th St., New York, can supply further details concerning the meeting.